TENTATIVE

STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

STATE OF NEVADA

DEPARTMENT OF HIGHWAYS

CARSON CITY

1957

NDOT
TE180
.N345
1957
Tentative

Contract unit price (bid) per —
Caps. for Engr. & Cont. ??

STATE OF NEVADA

DEPARTMENT OF HIGHWAYS

CARSON CITY, NEVADA

STANDARD SPECIFICATIONS
FOR
ROAD AND BRIDGE CONSTRUCTION

ASTM A 40

Charles H. Russell
Governor

H. D. Mills
State Highway Engineer

June, 1957

No. _____

STATE OF NEVADA

DEPARTMENT OF HIGHWAYS

CARSON CITY, NEVADA

STANDARD SPECIFICATIONS

FOR

ROAD AND BRIDGE CONSTRUCTION

TABLE OF CONTENTS*

		Page
PART I	GENERAL REQUIREMENTS	1
PART II	CONSTRUCTION DETAILS	56
PART III	MATERIAL DETAILS	318
	INDEX	381

*Detailed contents precede each part

TABLE OF CONTENTS*

		Page
PART I	GENERAL REQUIREMENTS	1
PART II	CONSTRUCTION DETAILS	55
PART III	MATERIAL DETAILS	318
	INDEX	381

*Detailed contents precede each part

PART I
GENERAL REQUIREMENTS

SECTION		PAGE
1	DEFINITION OF TERMS	1
2	BIDDING REQUIREMENTS AND CONDITIONS	7
3	AWARD AND EXECUTION OF CONTRACT	11
4	SCOPE OF WORK	13
5	CONTROL OF WORK	17
6	CONTROL OF MATERIAL	24
7	LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC	32
8	PROSECUTION AND PROGRESS	42
9	MEASUREMENT AND PAYMENT	48
10	WAGES AND CONDITIONS OF EMPLOYMENT	55

PART 1
GENERAL REQUIREMENTS

SECTION		PAGE
1	DEFINITION OF TERMS	1
2	BIDDING REQUIREMENTS AND CONDITIONS	7
3	AWARD AND EXECUTION OF CONTRACT	11
4	SCOPE OF WORK	13
5	CONTROL OF WORK	17
6	CONTROL OF MATERIAL	24
	LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC	28
8	PROSECUTION AND PROGRESS	42
9	MEASUREMENT AND PAYMENT	48
10	BASIS AND CONDITIONS OF ESTIMATES	53

PART I

GENERAL REQUIREMENTS

SECTION 1 - DEFINITION OF TERMS

Wherever in these specifications or in other contract documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

1.1 Abbreviations. Wherever the following abbreviations are used in the specifications or on the plans, they are to be construed the same as the respective expressions represented:

AASHO	American Association of State Highway Officials
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing Materials
AWS	American Welding Society
AWPA	American Wood Preservers Association
SAE	Society of Automotive Engineers.

1.2 Advertisement. The advertisement for proposal for all work or materials on which bids are to be accepted.

1.3 Award. The decision of the department to accept the proposal of the lowest responsible bidder for the work, subject to the execution and approval of a satisfactory contract therefor and bond to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.

1.4 Bidder. Any qualified individual, firm or corporation formally submitting a proposal for the work contemplated, or any portion thereof, acting directly or through a duly authorized representative.

1.5 Bridge. A structure, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of the roadway of more than twenty (20) feet between the under-copings of abutments or extreme ends of openings for multiple boxes ~~(and pipes)~~.

Length. The length of a bridge structure is the over-all length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor; but in no case less than the total clear opening of the structure.

Roadway Width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in the case of multiple height curbs, between the bottoms of the lower risers.

1.6 Calendar Day. Any day shown on the calendar.

1.7 Centerline. The centerline as laid out and staked by the engineer.

1.8 Contract Change Order. A written order to the contractor, signed by the engineer, ordering a change in the work from that originally shown by the plans and specifications. If the work is of a nature involving an adjustment of unit price, a supplemental agreement shall be executed. Contract change orders duly signed and executed by the contractor constitute authorized modifications of the contract.

1.9 Channel. A natural or artificial water course.

1.10 Contract. A written agreement executed between the department and the successful bidder, covering the performance of the work and the furnishing of labor and materials, by which the contractor is bound to perform the work and furnish the labor and materials, and by which the department is obligated to compensate him therefor at the mutually established accepted rate or price. The contract shall include the Notice to Contractors, Proposal, Contract Form and Contract Bond, these Specifications, Supplemental Specifications, all general or Special Provisions, general and Detailed Plans, and Notice to Proceed, also any written change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

1.11 Contract Bond. The approved form of security, executed by the contractor and his surety or sureties, guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and the payment of all legal debts pertaining to the construction of the project.

1.12 Contract Amount. The estimated contract cost computed on the basis of the proposal quantities and contract unit prices.

1.13 Contract Item (Pay Item). An item of work specifically described and for which a price, either unit or a lump sum, is provided. It includes the performance of all work and the furnishing of all labor, equipment, and materials, described in the text of a specification item included in the contract or described in any subdivision of the text of the supplemental specifications or special provisions of the contract. In these specifications, the contract items are numbered to correspond to sections, and each contract item shall be constructed under the specification contained in the section of the corresponding number.

1.14 Contractor. The party of the second part to the contract which shall be the individual, firm, or corporation undertaking the execution of the work under the terms of the contract and acting directly or through his, their, or its duly authorized agents or employees.

1.15 Culvert. Any structure not classified as a bridge which provides an opening under any roadway.

1.16 Department. The party of the first part to a contract which shall be the State Highway Department as constituted under the laws of the State of Nevada, for the administration of highway work.

1.17 Directors. The directors of the Department of Highways of the state of Nevada as established by law, acting directly or through their authorized representatives.

1.18 Divided Highway. A highway with separated roadways for traffic in opposite directions.

1.19 Employee. Any person working on the project mentioned in the contract of which these specifications are a part, and who is under the direction and control, or receives compensation from the contractor or his subcontractor.

1.20 Engineer. The State Highway Engineer of the state of Nevada, who is the executive officer of the Department of Highways, or an assistant or other representative duly authorized by the State Highway Engineer to act for him.

1.21 Equipment. All machinery, tools and apparatus, together with the necessary supplies for upkeep and maintenance, necessary for the proper execution of the work.

1.22 Extra Work. Work or material, the performance or furnishing of which is found necessary for the proper completion of the improvement, but which is not covered by any item of the proposal and for which no means of payment direct or indirect has been provided in the contract.

1.23 Frontage Road or Service Highway. A local street or road auxiliary to and located on the side of an arterial highway for service to abutting property and adjacent areas, and for control of access.

1.24 Highway. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

1.25 Holidays. In the state of Nevada these occur on:

New Year's Day	- January 1	Admission Day	- October 31
Memorial Day	- May 30th	Veteran's Day	- November 11th
Independence Day	- July 4th	Thanksgiving Day	
Labor Day	- First Monday of September	Christmas Day	- December 25th

or on any day that may be designated by the President of the United States or by the Governor of Nevada for public fast, thanksgiving or holiday.

If any holiday listed above falls upon Sunday the following Monday shall be considered as a holiday.

1.26 Inspector. The authorized representative of the engineer assigned to make any or all inspections of the work performed and the materials furnished by the contractor.

1.27 Laboratory. The established laboratory of the department or other laboratory designated by the engineer.

1.28 Major Item. Any contract item having an original contract value in excess of ten (10) percent of the original contract amount.

1.29 Materials. Any substances specified for use in the construction of the project.

1.30 Median. The portion of the divided highway separating the traveled ways for traffic in opposite directions.

1.30 Notice to Contractors. The official notice inviting bids for the proposed work.

1.32 Notice to Proceed. A written notice to the contractor designating the date on which he shall begin prosecution of the work.

1.33 Plans. The official approved plans, profiles, typical cross sections, working drawings and supplemental drawings, or reproduction thereof, which show the location, character, dimensions, and details of the work to be done, and which are to be considered as a part of the contract supplementary to these specifications and which are identified on the proposal form.

1.34 Project. The specific section of highway together with all appurtenances and construction to be performed thereon under the contract.

1.35 Proposal. The offer of the bidder, submitted on the prescribed proposal form, to perform the work and to furnish the labor and materials at the prices quoted by the bidder.

1.36 Proposal Form. The approved form upon which the Department requires formal bids to be prepared and submitted for the work.

1.37 Proposal Guaranty. The security furnished by the bidder with his proposal as a guaranty he will enter into a contract and furnish the required bond for the work if his proposal is accepted.

1.38 Right-of-Way. The land property or interests therein acquired for or devoted to highway purposes.

1.39 Roadbed. That portion of the roadway between outside shoulder lines, or between curbs.

1.40 Roadway. That portion of the right-of-way required for construction.

1.41 Shoulder. The portion of the roadbed contiguous with the traveled way for accommodation of stopped vehicles for emergency use, and for lateral support of base and surface courses.

1.42 Skew or Skew Angle. The acute angle formed by the intersection of a line normal to the centerline of the roadway with a line parallel to the face of the abutments, or in the case of culverts with the centerline of the culverts.

1.43 Special Provisions. Special directions, provisions, or requirements peculiar to the project under consideration and not otherwise thoroughly or satisfactorily detailed or set forth in the specifications. They set forth the final contractual intent as to the matter involved.

1.44 Specifications. The general term comprising all the directions, provisions and requirements contained herein, together with such as may be added or adopted as supplemental specifications or special provisions, all of which are necessary for the proper performance of the contract.

1.45 State. The state of Nevada acting through its authorized representatives.

1.46 Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end-walls, buildings, sewers, service pipes, underdrains, foundation drains and other features, which may be encountered in the work and not otherwise classed herein.

1.47 Subcontractor. Any individual, firm or corporation to whom the contractor, with the written consent of the department, sublets any part of the contract.

1.48 Subgrade. The portion of the roadbed prepared as a foundation for the base courses, curb and gutter and the surface course.

1.49 Substructure. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls and wingwalls.

1.50 Superstructure. All of that part of the structure above the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, except as noted above for substructure.

1.51 Superintendent. The executive representative of the contractor present on the work at all times during progress to supervise and direct the construction, authorized to receive and fulfill instructions from the engineer and to accept orders for changed and extra work.

1.52 Supplemental Agreement. A written agreement made and entered into by and between the contractor and the department covering work not otherwise provided for, revisions in or amendment to the terms of the contract, or conditions specifically prescribed in the specification as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

1.53 Supplemental Specifications. Specifications adopted subsequent to the publication of this book. They generally involve new construction items or substantial changes in the approved specifications.

1.54 Surety. The corporate body bound with and for the contractor, for the full and complete performance of the contract, and for payment of all debts pertaining to the work. When applying to the "Proposal Guaranty" it refers to the corporate body which engages to be responsible in the execution of a satisfactory contract by the bidder.

1.55 Traffic Lane. The portion of a traveled way for the movement of a single line of vehicles.

1.56 Traveled Way. The portion of the roadway for the movement of vehicles exclusive of shoulders and auxiliary lanes.

1.57 Work. The furnishing of all labor, materials, tools, supplies, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all of the duties and obligations as imposed by the contract.

1.58 Working Days. A calendar day, exclusive of Sundays, and state recognized holidays, on which weather or other conditions not under the control of the contractor, will permit construction operations to proceed for a period of five (5) daylight hours on the principal item or items of work which would

normally be in progress at that time, including final cleaning up as set forth in Article 4.7 of these supplemental specifications.

1.59 Working Drawings. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the contractor is required to submit to the engineer for approval.

Rev.

SECTION 2 - BIDDING REQUIREMENTS AND CONDITIONS

2.1 Notice to Contractors After the date is fixed for the letting of the work the department will give notice of such letting to contractors. The notice to contractors will contain a description of the proposed work, together with information to the bidder regarding access to proposal forms, plans and specifications, the amount and nature of proposal guaranty, and the reservation of the right of the department to reject any or all bids.

2.2 Prequalification of Bidders. All bidders shall be prequalified as required by law. To be qualified, a prospective bidder shall submit under oath, on the standard form furnished by the department, a statement of his financial ability and experience in the performance of contracts for public work. (Financial statements shall be prepared and certified by a certified public accountant, or by an accountant who has been previously approved by the department as being competent to prepare a contractor's financial statement.) After verifying the information contained in the statement, the department shall notify the submitter of the maximum contract amount and class of work upon which he will be eligible to bid.

Statements of financial ability and experience shall be submitted as of the date upon which the fiscal year of the prospective bidder ends.

In order to remain on the qualified list a prospective bidder shall submit a new statement at the close of his fiscal year. A prospective bidder not already qualified shall submit his statement of financial ability and experience at least five (5) full days prior to the date set for the opening of bids in which he is interested in order to have it considered, but qualification shall not be granted until such statement has been verified. Statements shall preferably be submitted at least thirty (30) days prior to bid opening.

Nothing contained in this section shall be construed as depriving the department of its discretion in the matter of determining the lowest responsible bidder.

No bid will be accepted from, or a contract awarded to, a contractor who is not licensed in accordance with the law under the provisions of Nevada Revised Statutes Chapter 624, as amended to date, and to whom a proposal form has not been issued by the Department of Highways.

2.3 Plans and Contents of Proposal Form. Qualified prospective bidders, upon request, will be furnished by the department, with a proposal form. This form will state the location and description of the contemplated construction and will show the approximate estimate of the various quantities of work to be performed or materials to be furnished, with a schedule of items for which unit bid prices are invited. It will state the time in which the work must be completed, the amount of the proposal guaranty, and the date, time and place of the opening of proposals. The form will also include any special provisions or requirements which vary from or are not contained in the standard specifications.

All papers bound with or attached to the proposal form are necessary parts thereof and must not be detached or altered.

The plans, specifications and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

A bidder will be required to deposit with the department the sum stated in the "Notice to Contractors" for each copy of proposal form and plans.

Plans and special provisions for individual projects may be obtained for inspection purposes by interested non-bidding concerns upon receipt of the sum stated in the "Notice to Contractors". Plans and specifications obtained on this basis are non-returnable and no refund will be made.

2.4 Interpretation of Quantities in the Proposal. The quantities appearing in the prepared proposal are approximate only and are prepared for the comparison of bids. Payment to the contractor will be made for actual quantities of work performed or materials furnished in accordance with the contract, and it is understood that the scheduled quantities of work to be done and materials to be furnished may be increased, diminished, or omitted as hereinafter provided, without in any way invalidating the unit prices bid.

2.5 Examination of Plans, Specifications, Special Provisions, and Site of Work. The bidder is required to examine carefully the site of the proposed work, the proposal, plans, specifications, special provisions, and contract forms before submitting a bid. It is mutually agreed that submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, supplemental specifications, special provisions and contract.

Information pertaining to exploration, borings, test pits, locations, and other preliminary investigation may appear on the plans or in the special provisions. While such data will have been collected with reasonable care, there is no expressed or implied guaranty that conditions so indicated are exact or entirely representative of those actually existing. The bidder shall put his own interpretation on results of such investigations and satisfy himself as to the conditions to be encountered.

2.6 Preparation of Proposal. The bidder shall submit his proposal upon the blank forms furnished by the department. The bidder shall specify a unit price in both words and figures for each and every item for which a quantity is given, and shall also show the products of the respective unit prices and quantities, written in figures in the column provided for that purpose, and the total amount of the proposal obtained by adding the amounts of the several items.

All words and figures shall be written in ink or typewritten. In case of a discrepancy between the prices written in words and those written in figures, the written words shall govern.

The bidder's proposal shall be signed with ink by the individual, by one or more members of the partnership, or by one or more of the officers of the corporation submitting it.

2.7 Irregular Proposals. Proposals shall be considered irregular and may be rejected for the following reasons:

(a) If the proposal form furnished by the department is not used or is altered.

(b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.

(c) Except as provided in Article 2.14, if the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.

(d) If the unit prices contained in the proposal are obviously unbalanced, either in excess or below the reasonable cost analysis values.

(e) If they fail to contain a unit price for every pay item indicated, except in case of authorized alternate pay items.

2.8 Proposal Guaranty. No proposal will be considered unless accompanied by an undertaking executed by a corporate surety company authorized to do business in the state of Nevada, in an amount equal to five (5) percent of his bid, or in the alternative every proposal shall be accompanied by cash, a cashier's check, or a certified check of the bidder in an amount equal to five (5) percent of his bid; said check to be made payable to the State Highways Fund; and said undertaking provided for herein, if used, to be conditioned to the effect that should the bidder to whom the contract is awarded fail to enter into the contract in accordance with the proposal, and to give the bond required by the said contract within fifteen (15) calendar days after notice of such award, said surety company shall forthwith pay into the State Highways Fund the sum set forth in the undertaking.

2.9 Delivery of Proposals. Each proposal shall be placed, together with the proposal guaranty, in a sealed envelope so marked as to indicate the identity of the project and the name and address of the bidder. Proposals will be received at the place designated in the advertisement and the Notice to Contractors until the hour on the date set for the opening thereof, and must be in the hands of the engineer by that time. When sent by mail, the sealed proposal must be addressed to the department at the address and in care of the official in whose office the proposals are to be received. All proposals shall be filed prior to the time and at the place specified in the advertisement and Notice to Contractors. Proposals received after the time for opening of proposals will be returned to the bidder unopened.

2.10 Withdrawal or Revision of Proposals. A bidder may, without prejudice to himself, withdraw a proposal after it has been deposited with the department, provided the request for such withdrawal is received by the department in writing, by telegram or by teletype, before the time set for opening proposals. The withdrawal of a proposal shall not prejudice the right of the bidder to file a new proposal provided it is received prior to the time set for opening proposals.

2.11 Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the Advertisement and Notice to Contractors. Bidders, their authorized agents, and other interested parties are invited to be present.

2.12 Disqualification of Bidders. Any one or more of the following causes may be considered as sufficient for the disqualification of a bidder and the rejection of his proposal or proposals.

(a) Reasonable grounds for believing that any bidder is interested in more than one proposal on the same contract or that collusion exists among the existing bidders.

(b) Dishonesty or lack of good faith and lack of intent to do the work according to the plans and specifications.

(c) Lack of competency and adequate machinery, plant or other equipment as revealed by the Financial Statement and Experience Questionnaires required under Article 2.2.

(d) Failure to hold a valid license of a class corresponding to the work to be done as required by the State Contractors' License Law.

(e) Submittal of a proposal form which has not been issued specifically for the purpose of submitting a bid for the project under consideration.

(f) Unsatisfactory performance record as shown by past work for the department judged from the standpoint of workmanship and progress.

(g) Uncompleted work which in the judgment of the Department might hinder or prevent the prompt completion of additional work if awarded.

(h) Failure to pay or satisfactorily settle all bills due for labor and material on former contracts in force at the time of letting.

(i) Failure to comply with any qualification regulations for the department.

2.13 Material Guaranty. Before any contract is awarded, the bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work, together with samples, which samples may be subjected to the test provided for in these specifications to determine their quality and fitness for the work.

2.14 Qualification of Bids. A bidder who desires to bid upon more than one project at a single letting, but who desires to protect himself against receiving the award of more projects than he is equipped to handle, may bid upon any number of projects, securing the protection desired by making the following written statement signed by the bidder and attached to the proposal form for each of the projects:

"This proposal is conditioned upon my (or our) receiving the award of contract for only one of the projects for which I (or we) have submitted proposals at this letting. If the contract for any other project is awarded to me (or us), then this proposal shall be considered withdrawn".

In case a bidder who has conditioned his proposal, as above provided, is low bidder on more than one project, it shall be optional with the department as to which one of the projects is awarded to him.

2.15 Motor Fuel Tax Refund. It is understood and agreed that the price bid by the contractor for the work to be done under this contract shall include the state tax on all gasoline, distillate, diesel fuel, and other motor fuels used in the performance of the work including that used in the operation of stationary engines, tractors, and power shovels, as well as that used in motor vehicles; and it is further agreed, that if any refund of said state tax is received by the contractor or his subcontractors, or employees, on gasoline, distillate, diesel fuel or other motor fuels used in the performance of the work incidental to this contract, the amount thereof shall be credited to the state on amounts due to the contractor under this contract or shall be paid to the state by the contractor in cash.

SECTION 3 - AWARD AND EXECUTION OF CONTRACT

3.1 Consideration of Proposals. After the proposals are opened and read they will be compared on the basis of the summation of the products of the items of the approximate quantities shown in the bid schedule by the unit bid prices. The results of such comparisions will be immediately available to the public. In the event of a discrepancy between unit bid prices and extensions the unit bid price shall govern.

In the event that the sum of the amount of the proposal and the sum of the amounts of work under contract and incomplete is in excess of the bidders' qualification established as provided in Article 2.2, the right is reserved to reject such proposal.

If proposals for more than one project are issued to a bidder, which projects individually would be within the bidder's qualification established as provided in Article 2.2, but a combination of more than one, considering also the work under contract and incomplete, would be in excess of his qualification, the right is reserved to consider only such proposal or proposals as in the opinion of the directors are within such rating and most advantageous to the state.

The right is reserved to reject any or all proposals, to waive technicalities, to advertise for new proposals, or to proceed to do the work otherwise if in the judgment of the directors the best interest of the state will be promoted thereby.

3.2 Award of Contract. The award of the contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed. The award, if made, will be made within thirty (30) calendar days after the opening of the proposals. The successful bidder will be notified by letter, mailed to the address shown on his proposal, that his proposal has been accepted and that he has been awarded the contract.

3.3 Cancellation of Award. The directors reserve the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the department.

3.4 Return of Proposal Guaranty. All proposal guaranties, except those of the two lowest bidders, will be returned immediately following the opening and checking of the proposals. The other two guaranties will be returned immediately after the award of the contract and after satisfactory bond has been furnished and the contract has been executed except when the proposal guaranty has been forfeited as liquidated damages as provided in Article 3.7.

3.5 Requirements with Respect to Contract Bond. The successful bidder shall, at the time of the execution of the contract, furnish a surety bond or bonds in a sum equal to the full amount of the contract as a guaranty that he will complete the work in accordance with the terms of the contract. Such bond, or bonds, shall also provide and secure payment for all materials, labor, and supplies, trucks, and other means of transportation, used in, or upon, or about, or for the performance of the work contracted to be done, and for any work

or labor done thereupon or incidental thereto. The bond or bonds shall be on the form provided in the proposal and shall be written by a surety approved by the Insurance Commissioner of the state of Nevada. A power of attorney for an attorney infact who executes bonds shall be registered with, and approved by, the Insurance Commissioner of the State of Nevada. The power of attorney shall show the limiting amount authorized for issuance of bonds. Written appointment of agent of bonding company in and for the state of Nevada shall also be registered with, and approved by, the Insurance Commissioner.

3.6 Execution and Approval of Contract. The contract shall be signed by the successful bidder and returned, together with the contract bond within fifteen (15) calendar days after the bidder has received notice that the contract has been awarded. If the contract is not executed by the department within thirty (30) calendar days after receiving signed contracts and bonds from the contractor, he shall have the right to withdraw his bid without penalty. No contract shall be considered as effective until it has been finally executed by all parties thereto and approved.

3.7 Failure to Execute Contract. Failure to execute contract and file an acceptable bond within fifteen (15) calendar days after the bidder has received notice that the contract has been awarded shall be just cause for the annulment of the award and the forfeiture of the proposal guaranty which shall become the property of the department, not as a penalty, but as liquidation of damages sustained. Award may then be made to the next lowest responsible bidder, or the work may be re-advertised and constructed under contract or otherwise, as the department may decide.

SECTION 4 - SCOPE OF WORK

4.1 Intent of Contract. The intent of the contract is to prescribe a complete work or improvement which the contractor undertakes to do, in full compliance with the plans, specifications, special provisions, proposal, and contract. They are to be cooperative and what is called for in one is as binding as if called for in all.

Plans represent the conditions as foreseen; however, the various quantities represented thereon may, if necessary, be increased or diminished during construction without impairing the contract.

The contractor shall perform all work in accordance with lines, grades, typical cross-section and dimensions and other data shown on the plans or as modified by written orders, including the furnishing of all materials, implements, machinery, equipment, tools, supplies, transportation, labor, and for all other things necessary to the satisfactory prosecution and completion of the project.

4.2 Special Work. Should any construction or conditions which are not covered by the plans or these specifications be anticipated, "Special Provisions" for such work will be prepared by the engineer, stated on insert sheets attached to the proposal forms and such "Special Provisions" shall be considered a part of these specifications the same as though contained herein. Should any such "Special Provisions" or requirements conflict with these specifications or supplements thereto, the "Special Provisions" shall govern.

4.3 Increased or Decreased Quantities of Work. The engineer reserves the right to make, by written order and without notice to surety, such alterations in the plans or character or quantity of the work which may be considered necessary or desirable from time to time during the progress of the work to complete satisfactorily the proposed construction. Such alterations shall not be considered as a waiver of any conditions of the contract or invalidate any of the provisions thereof.

The right is reserved to increase or decrease any or all of the items in the estimate of approximate quantities as shown in the proposal. The length of the project may be increased or decreased by adding or omitting sections or by relocation.

Whenever the termini of the project are changed and whenever any change or combination of changes results in increasing or decreasing the original contract amount as calculated from the bid quantities and contract unit prices by more than twenty-five (25) percent, a supplemental agreement acceptable to both parties to the contract shall be executed in advance of performing the affected work.

Whenever an overrun or underrun of more than twenty-five (25) percent of the original bid quantity for one or more major contract items occur, except items of overhaul, structure excavation, backfill, piling, concrete, seal courses, water, rolling, and such other items as may be specifically excluded in the special provisions, either party to the contract may demand a supplemental agreement be negotiated with an adjustment of unit price or prices satisfactory to both parties. A major contract item shall be defined as any item whose total cost

determined by multiplying the proposal quantity and contract item price, is equal to or greater than ten (10) percent of the total original contract amount.

Whenever an alteration in character of work involves a substantial change in the nature of the design or in the type of construction which materially increases or decreases the cost of the performance, the work shall be performed in accordance with the specifications and as directed, provided however, that before such work is started a supplemental agreement acceptable to both parties to the contract shall be executed.

If it is found that the quantity of any major item required to complete the work underruns or overruns not more than twenty-five (25) percent of the proposal quantity, payment for the work performed will be made at the contract unit price for the quantity of work actually performed.

If it is found that any major item underruns more than twenty-five (25) percent of the original proposal quantity, and as a result thereof the unit cost of performing the work is materially increased, the contractor may submit a request for revision of the contract unit price for such item and shall submit therewith evidence to support his claim. Such claim will be considered insofar as it justifies an increase in the pro rata share of the fixed expenses chargeable to such item because of the decreased quantity of the item, provided, however, no allowance shall be made for anticipated profits on the amount the quantity underruns the original proposal quantity, and further provided, that the total payment for the decreased quantity shall not exceed that which would be made for seventy-five (75) percent of the proposal quantity at the contract unit price.

Revision of any unit price requested by the contractor shall be negotiated on the basis of actual cost plus a reasonable allowance for profit and overhead. Written request for supplemental agreement shall set forth in detail the particulars and character by which the work was changed and by what amount the unit price of the proposal item will be altered. Failure of the contractor to file a request for a supplemental agreement within ten (10) calendar days after any of the above outlined conditions are encountered shall be considered as a waiver thereof on part of the contractor and payment shall be made at the contract unit price for the actual quantity of work performed.

If a supplemental agreement satisfactory to both parties cannot be agreed upon, the engineer may order the work in dispute to be performed on a force account basis or he may cancel the work from the contract.

Changes not requiring negotiated agreements, except as to extra work involved, shall be ordered by means of a contract change order, and acceptance by the contractor, as evidenced by his signature, shall constitute agreement that the change does not involve any adjustment of contract unit prices. Should the nature of the change order be such that the adjustment of contract time for completion as provided in Article 8.8 for increased quantities of work is not equitable, the engineer shall determine the additional time to be allowed, and such time shall be stated on the order. Work shall not be started on any such change until the change order has been delivered to the contractor and accepted by him.

In case the contractor refuses to accept a change order because he considered the change to involve an adjustment of prices, or agreement cannot be reached in regard to price adjustment for a supplemental agreement, the engineer may order the work to proceed and defer settlement of the disputed points.

4.4 Extra Work. Extra work shall be performed by the contractor, upon receipt of a written order to perform such work, in accordance with the specifications and as directed. Such order shall be on the standard contract change order form. The order shall state the work to be done, the method of payment and the estimated total cost. The method of payment may be agreed unit prices, force account, or a combination of the two. Agreed unit prices together with the estimated quantities of each unit shall be shown. Orders involving force account work shall be detailed as required in Article 4.5.

Should the nature of the extra work be such that the adjustment of contract time for completion, as provided in Article 8.8 for increased quantities of work, is not equitable, the engineer shall determine the additional time to be allowed, and such time shall be stated on the order.

If it is found necessary during the progress of the work to exceed the total estimated cost by more than fifteen (15) percent, or to use equipment, materials, or items not listed in the order, a supplemental order shall be issued before such additional cost is incurred or such additional equipment or materials are used.

Acceptance of the order by the contractor as evidenced by his signature, shall constitute his agreement to unit prices or rental rates indicated on the order as agreed prices or rates.

4.5 Force Account Work. When the proposal includes an item or items to be done by force account, or when a supplemental agreement or contract change order provides for doing certain work by force account, such work shall be performed upon receipt of a written order issued by the engineer. The order shall include the following details:

(a) Statement of work to be done.
(b) Estimated number of hours and estimated hourly wage for each class of labor.
(c) Estimated number of hours and rental rate for all equipment.
(d) Amount and estimated cost of all materials.
(e) Estimated total cost.

The rental rates shall be the contract rates if any, otherwise they shall be agreed rates. In case rental rates cannot be agreed upon, the engineer may so indicate on the order and use for estimate purposes when he considers a fair price, deferring for future settlement the final rates to be used.

If it is found necessary during the progress of the work to exceed the total estimated cost by more than fifteen (15) percent, or to use equipment, materials, or items not listed in the order, a supplemental order shall be issued before such additional cost is incurred or such additional equipment or materials are used.

Acceptance of the order by the contractor, as evidenced by his signature, shall constitute his agreement to unit prices or rental rates indicated on the order as agreed prices or rates.

The plan of work to be followed, the equipment to be used, and the amount and class of labor to be employed shall be determined by the engineer.

4.6 Rights in and Use of Materials Found in the Work. The contractor, with the approval of the engineer, may use on the proposed construction suitable stone, gravel, or sand found in the excavation, and will be paid for the

excavation of such materials at the corresponding contract unit price therefor, but he shall replace at his own expense with other acceptable material all that portion of the materials so removed and used as was contemplated for use in the embankments, backfills, approaches, or otherwise. No charge for materials so used shall be made against the contractor except the replacement herein provided for. The contractor shall not excavate or remove any material from within the highway right of way which is not within the excavation as indicated by the slope and grade lines, without written authorization from the engineer.

4.7 Final Cleaning Up. Before final acceptance, the contractor shall remove or obliterate, insofar as feasible, all objects or disturbances of the ground which mar the landscape and were caused by his operations, but which are not part of the improvement. This shall be required on all areas used or occupied by the contractor, regardless of right of way limits.

Rubbish, excess material, temporary structures, and discarded equipment shall be collected and burned, buried, or otherwise disposed of as directed by the engineer. Pits or trenches for equipment set-ups or camp sites shall be filled and the ground restored, insofar as feasible, to its original condition. Temporary haul roads shall be scarified and bladed to blend with surroundings. Pits from which materials have been obtained shall be dressed and shaped to conform with the surrounding ground. Waste shall be removed from the tops of banks and placed in the bottom of the pit. Except on steep sidehills, the banks of pits shall be cut to not steeper than one to one (1:1) slope to blend with the natural contours. Bottoms of pits shall be reasonably smooth and level. All other disturbances shall be removed or corrected as directed by the engineer.

SECTION 5 - CONTROL OF WORK

5.1 Authority of the Engineer. All work shall be done under the supervision of the engineer and to his satisfaction. In order to prevent litigation and misunderstanding and so that the work may be expedited and fulfill all the requirements of the proposal the engineer shall:

(a) Decide and determine mutual rights between contractors;

(b) Decide any and all questions which may arise as to the quality and acceptability of materials furnished and work performed;

(c) Decide as to the manner, the performance and the rate of progress of the work;

(d) Decide all questions which may arise as to the interpretation of the specification and plans relating to the work;

(e) Decide all questions as to the acceptable fulfillment of the contract on the part of the contractor;

(f) Determine the amount and validity of the several kinds of work performed and materials furnished which are to be paid for under the contract;

(g) Exercise such other authority as given under these specifications.

His decision shall be final and he shall have executive authority to enforce and make effective such decisions and orders as the contractor fails to carry out promptly, and in case of failure on part of the contractor to execute the work ordered by the engineer within a reasonable time, the engineer may, after giving notice in writing to the contractor, proceed to execute such work as may be deemed necessary and the cost thereof shall be deducted from compensation due or which may become due the contractor on the contract.

Decisions of the engineer shall be subject to appeal to the Board of Directors, whose decisions shall be final and conclusive. Such appeal shall be in writing and shall be made within ten (10) calendar days, but in the meantime the contractor shall diligently proceed with the work.

The expressions used in these specifications such as "satisfactory to the engineer", "as directed by the engineer", and others of like import are not used for the purpose of giving the engineer extra legal authority beyond what is herein defined but are employed for the purpose of an advanced agreement on what is deemed somewhat controversial and difficult to define in a specification covering all cases. They are used for the purpose of arriving at a practical solution of controversial matters for the mutual benefit of the contractor and the state.

Plans consisting of general drawings and showing such details as are necessary to give a comprehensive idea of the construction contemplated will be furnished by the department.

5.2 Plans and Working Drawings. The approved plans shall be supplemented by such working drawings as are necessary to control the work adequately. All authorized alterations affecting the requirements and information given on the

approved plans shall be in writing. No changes shall be made of any plan or drawing after it has been approved by the engineer, except by direction of the engineer.

Structure plans will in general show in detail all dimensions of the work contemplated. When the structure plans do not show all of the dimensions in detail, they will show general features and such details as are necessary to give a comprehensive idea of the structure.

The contractor shall furnish on the size sheets required herein or by the engineer such working and detail drawings not furnished by the department as may be required for any part of the finished structure.

Working drawings for steel structures shall consist of shop detail erection and other work plans showing details, dimensions, sizes of material and other information necessary for the complete fabrication and erection of the metal work.

Working drawings for concrete structures shall consist of such detailed plans as may reasonably be required for the successful prosecution of the work and which are not included in the plans furnished by the department. These may include plans for falsework, bracing, centering, and form work and masonry layout diagrams.

The contractor shall submit to the engineer for approval not less than three (3) sets of any required preliminary detail or shop working drawings. These plans shall be submitted in sufficient time to allow discussion and correction prior to beginning the work they cover. Prior to the approval of these drawings any work done or materials ordered for the structures involved shall be at the contractor's risk. One (1) set of these drawings shall be returned to the contractor approved or marked with corrections to be made. The other sets shall be retained by the engineer.

It is expressly understood that the approval by the engineer of the contractor's working drawings relates to the requirements for strength and detail and such approval shall not relieve the contractor from responsibility for errors in dimensions.

The contractor shall furnish the engineer with such blue print copies of the working drawings as may be required for approval and construction purposes.

The contract price shall include the cost of furnishing all working drawings and the contractor will be allowed no extra compensation for such drawings.

5.3 Conformity with Plans and Allowable Deviations. Finished surfaces in all cases shall conform with lines, grades, and dimensions and adjustment shown on the approved plans, except as modified by written order by the engineer. The crown, or rise of the finished surfaces of the roadway from the curb or side line to the centerline, shall be as shown on the typical cross section of the plans, except at intersecting highways or wherever, to insure correct drainage or for other reasons, changes may be directed. On curves or at other places where deemed necessary the contractor will be required to widen, superelevate or spiral the roadway according to department standards. Any deviations from the plans and approved working drawings, as may be required by the exigencies of construction, or otherwise, will in all cases be determined and authorized by the engineer in writing.

5.4 Coordination of Plans, Specifications, Supplemental Specifications and Special Provisions. These specifications, supplemental specifications, the

plans, special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary, to describe and provide for a complete work. In the event of any discrepancy between the drawings and figures written thereon, the figures unless obviously incorrect are to govern over scaled dimensions. In the case of any discrepancy between the plans and the specifications, the plans are to govern. If there is a discrepancy between these standard specifications and supplemental specifications, the supplemental specifications are to govern. Special provisions shall govern over specifications, supplemental specifications, and plans.

Should it appear that the work to be done, or any of the matters relative thereto, is not sufficiently detailed or explained on the plans or in the specifications or special provisions, the contractor shall make written application to the engineer for such further explanations as may be necessary, and shall conform to the explanations given as part of the contract.

5.5 Cooperation of Contractor. The contractor will be supplied with four copies of approved plans, and contract assemblies including special provisions, and shall have available on the work at all times at least one copy of these plans, and special provisions. Additional copies of plans and special provisions may be obtained by the contractor upon written request to the department. The expenses incurred by the department for printing, assembly, postage and materials for the additional copies will be billed at cost to the contractor and payment of such billing shall become due and payable within ten (10) days after the invoice date.

The contractor shall give the work the constant attention necessary to facilitate the progress thereof and shall cooperate with the engineer, his inspectors and other contractors in every way possible.

The directors reserve the right at any time to contract for and perform other or additional work on or near the work covered by any contract.

The contractor shall arrange and conduct his work so as not to interfere with the operations of other contractors engaged upon or near the work, and to join his work to that of others in a proper manner and in accordance with the spirit of the plans and specifications and to perform his work in the proper sequence in relation to that of other work or as may be directed by the engineer.

The contractor shall be held responsible for any damage done by him or his agents to the work performed by another contractor. Each contractor shall so conduct his operations and maintain the work in such condition that adequate drainage shall be in effect at all times. In case of dispute between contractors working on the same project, the engineer shall be the referee and his decision shall be final and binding on all.

Each contractor involved shall assume all liability, natural or otherwise, in connection with his contract and shall protect and save harmless the state from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operations of other contractors working within the limits of the same project, and he shall assume all responsibility for all work not completed or accepted because of the presence and operation of the other contractors.

The contractor shall at all times during the progress of construction have a competent superintendent capable of reading and thoroughly understanding the plans and specifications as his agent on the work, who shall receive in-

structions from the engineer or his authorized representatives. The superintendent shall have full authority to execute the orders or directions of the engineer without delay, and to supply promptly such materials, tools, plant equipment and labor as may be required to properly perform the work. Such superintendent shall be furnished, irrespective of the amount of work sublet.

5.6 Cooperation with Utilities. It shall be the department's duty to notify all utility companies, all pipe line owners, or other parties affected, in an endeavor to have all necessary adjustments of public or private utility fixtures, pipe lines and other appurtenances within or adjacent to the limits of construction made as soon as practicable.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction are to be moved by the owners at their expense, except as otherwise provided for in the special provisions or as noted on the plans.

It is understood and agreed that the contractor has considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated positions as shown on the plans and that no additional compensation will be allowed for any delays, inconvenience or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them.

5.7 Construction Stakes. The engineer will furnish and set construction stakes establishing lines and grades in road work, roadway and waterway center lines, and bench marks for bridge work, and will furnish the contractor with all necessary information relating to lines and grades. These stakes and marks shall constitute the field control by and in accordance with which the contractor shall govern and execute the work. In case of bridges, if requested by the contractor, the engineer will furnish stakes determining the centerlines of all piers, pedestals, or abutments, together with stakes determining the angles of the wings or retaining walls. The contractor shall furnish, free of charge, all additional stakes, all templates, and other materials necessary for marking and maintaining points and lines given. The contractor shall construct the work in accordance with the engineer's stakes and marks, making use of them before they are disturbed, and shall be charged with full responsibility for conformity and agreement of the work with such stakes and marks. The contractor shall be held responsible for the preservation of all stakes and marks, and if, in the opinion of the engineer, any of the stakes or marks have been carelessly or wilfully destroyed or disturbed by the contractor the cost of replacing them shall be charged against, and shall be deducted from, the payment for the work.

5.8 Authority and Duties of Inspectors. Inspectors, employed by the department, shall be authorized to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector is not authorized to revoke, alter, or waive the provisions of these specifications.

As the inspector is placed on the work to keep the engineer informed of the progress of the work and the manner in which it is being done, also to call the contractor's attention to any non-conformance with the plans or specifications, he will not be authorized to approve or accept any portion of the project, to issue instructions contrary to the plans and specifications, or to act as foreman for the contractor. The inspector will have authority to reject defective material and to

to suspend any work that is being improperly performed, subject to the final decision of the engineer, provided the suspension is confirmed in writing.

5.9 Inspection. All materials, and each part or detail of the work shall be subject at all times to inspection by the engineer or his authorized representatives, and the contractor will be held strictly to the true intent of the specifications in regard to the quality of materials, workmanship, and the diligent execution of the contract. Such inspection may include mill, plant, field or shop inspection and any material furnished under the specification is subject to such inspection. The engineer or his representative shall be allowed access to all parts of the work and shall be furnished with such information and assistance as is required to make a complete and detailed inspection. The contractor shall, if the engineer requires, remove or uncover such portion of the finished work as the engineer may direct before the final acceptance of the same. After examination the contractor shall restore such portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed shall be paid for as extra work, but should the work so exposed or examined prove unacceptable, the uncovering or removing shall be at the contractor's expense.

Any work done or materials used without supervision or inspection by a department representative may be ordered removed and replaced at the contractor's expense. Failure to reject any defective work or material shall not in any way prevent later rejection when such defect is discovered, or obligate the department to make final acceptance.

When the United States government or any railroad corporation is to pay a portion of the cost of the work covered by this contract, their respective representatives will have the right to inspect the work.

5.10 Removal of Defective and Unauthorized Work. All work and materials which do not conform to the requirements of the contract shall be considered as defective work.

Any defective work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause, found to exist prior to acceptance of final payment for work, shall be removed immediately and replaced by work or materials which shall conform to the specifications, or shall be remedied otherwise in an acceptable manner authorized by the engineer. This clause shall have full effect regardless of the fact that the defective work may have been done or the defective materials used with the full knowledge of the inspector. The fact that the inspector in charge may have previously overlooked such defective work shall not constitute an acceptance of any part of it.

No work shall be done without lines and grades having been given by the engineer. Any work which may be done by the contractor prior to approval of the contract, work done contrary to or regardless of the instructions of the engineer, work done beyond the lines shown on the plans, or as given, except as herein specified, or any extra work done without written authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the contractor's expense.

Upon failure on the part of the contractor to comply promptly with any order of the engineer made under the provisions of this article, the engineer sha shall have authority to cause defective work to be remedied or removed and replaced and unauthorized work to be removed, and to deduct the costs from any moneys due or to become due the contractor.

5.11 Load and Speed Restrictions. The contractor shall be responsible for all damage caused by his hauling equipment within the limits of the project.

In hauling materials for incorporation in portions of highways under construction or reconstruction, hereinafter called the project, loads which are in excess of the limits set by the department will not be permitted on any new or existing bridge or bituminous surface which is to remain in place for vehicular traffic within the project or between the project and the pits or other sources of materials described by the department for use on the project. Load limits established by the department for the project shall be complied with regardless of the source of materials, whether from described pits, approved pits or commercial sources. Unless otherwise stated in the special provisions the maximum loads shall not exceed the limits set forth in Nevada Revised Statutes 484.530 et. seq. and all acts ammendatory thereto or supplementary thereof.

The engineer may, at his discretion, establish speed limits on or adjacent to the project. Such limitations of speed shall be strictly observed by the contractor.

5.12 Maintenance During Construction. The contractor shall maintain the work during construction and until the work is finally accepted. This maintenance shall constitute continuous and effective work prosecuted day by day with adequate equipment and forces to the end that the roadway, or structures, are kept in satisfactory condition at all times.

Unless otherwise provided, all costs of maintenance work during construction and before the work is finally accepted shall be included in the unit prices bid on the various pay items and the contractor will not be paid an additional amount for such work.

In the event that the contractor's work is ordered shut down for failure to comply with the provisions of the contract, the contractor shall maintain the roadway and structures as provided herein and provide such ingress or egress for local residents as may be necessary during the period of suspended work or until the contract has been declared in default.

Failure on the part of the contractor at any time to comply with the provisions of this article will result in the engineer immediately notifying the contractor to comply with the required maintenance provisions. In the event that the contractor fails to remedy unsatisfactory maintenance within twenty-four (24) hours after receipt of such notice, the engineer will immediately proceed with adequate forces and equipment to maintain the project and the entire cost of this maintenance shall be deducted from moneys due or which may become due the contractor on his contract.

5.13 Final Inspection. Whenever all the materials have been furnished, all the work has been performed, and the construction provided and contemplated by the contract has been satisfactorily completed, all in accordance with the plans, specifications, and special provisions, the engineer shall make the final inspection.

Upon due notice from the contractor of presumptive completion of the entire project, the engineer shall make a semi-final inspection and if, at such semi-final inspection, all construction provided for and contemplated by the contract is found completed to his satisfaction, such inspection shall constitute the final inspection and the engineer shall make the final acceptance and the contractor shall be notified of such acceptance in writing within ten (10) calendar days or as soon thereafter as practicable.

If, however, on any semi-final inspection any work in whole or in part is found unsatisfactory, the engineer shall give the contractor the necessary instructions as to replacement of material and performance or reperformance of the work necessary and prerequisite to final completion and acceptance, and the contractor forthwith shall comply with and execute such instructions. Upon satisfactory replacement of such material and performance or reperformance of such work another inspection shall be made which shall constitute the final inspection if the said material is found to have been replaced and the work completed satisfactorily.

SECTION 6 - CONTROL OF MATERIAL

6.1 Source of Supply and Quality Requirements. These specifications contemplate the use of new, unused, first-class materials throughout the work, except as may specifically be provided elsewhere in these specifications, on the plans or in the special provisions, incorporated in the work in such manner as to produce completed construction which is workmanlike and acceptable in every detail. Only materials conforming with requirements of the specifications shall be used.

The source of supply of each of the materials or finished products shall be subject to approval by the engineer before delivery is started. If it is found, after trial, that sources of supply previously approved do not produce uniform and satisfactory products, or if the product from any source proves unacceptable at any time, the contractor shall furnish materials from other approved sources.

If the contractor desires to furnish materials from sources not previously approved, he shall first secure approval of the source by the engineer. The contractor shall give notice of such desire sufficiently in advance to permit completion of the tests necessary to grant approval. He shall furnish without charge such preliminary samples as may be required. Tests will be made and reports rendered at the sole expense of the contractor, but it is understood that such tests shall in no way be construed as a guaranty of acceptance of any material which may be delivered later for incorporation in the work. Only the materials actually delivered for the work will be considered and their acceptance or rejection shall be based solely on the results of the tests prescribed in the specifications.

The contractor shall assume full responsibility for the production of uniform and satisfactory materials from local deposits, and shall indemnify and save harmless the department from any and all claims for loss or damages resulting ffom the opening and operation thereof or from the failure of the deposit after development to produce materials acceptable to the engineer, in either quality or quantity.

6.2 Local Materials. Possible sources of local materials may be indicated on the plans and described in the special provisions. The quality of material in such deposits will be acceptable in general, but the contractor shall determine for himself the amount of equipment and work required to secure a finished product meeting the specifications, and whether blending with other materials will be necessary. It shall be understood that it is not feasible to ascertain from samples, limits for an entire deposit, and that variations shall be considered as usual and to be expected. It shall also be understood that the engineer may order procurement of materials from any portion of any deposit and may reject portions of the deposit as unacceptable.

The department may, at its sole discretion, acquire and make available to the contractor the right to remove materials from those sources shown on the plans or described in the special provisions, or may describe acceptable sources without acquiring any right to remove materials. In the event that such acquisition is made by the department, notice thereof will be given in the special provisions and the successful bidder shall, at the time of execution of the contract, execute an acceptance of an assignment from department of the right to remove materials from said described source upon the form furnished by the department, whether the material source be used by the contractor or not.

Material taken from sources described in the special provisions shall be paid for at the rate and in the manner specified in the contract between department and source owner; or if department describes a source but does not acquire the right to remove materials, the contractor shall at his sole expense acquire the right to remove materials and pay all costs for such removal. Payment shall be made by the contractor, to the source owner, at the specified cost per unit of measure on the basis of the engineer's estimate in accordance with said contract.

The contractor shall be bound by all conditions and terms contained in said contract between department and source owner, and shall save the department free and harmless from all liability arising by, between or from source owner and/or contractor.

When material deposits are shown on the plans or in the special provisions, the contractor shall not use material from another deposit until written approval of the change has been received from the engineer. It is understood that approval of a deposit other than described will not increase the cost of the work. The engineer assumes no responsibility for the quantity of acceptable material in any deposit.

If the contractor desires to use materials from sources other than those described and/or acquired by the department, he shall, at his own expense, acquire the necessary right to take materials and pay all costs involved, including any which may result from an increase in length of haul. All costs of exploring and developing such alternate sources shall be borne by the contractor and the use of material from these sources will not be permitted until representative samples taken by the engineer have been approved and written authority issued for the use thereof. Approval for the use of material from such alternate sources will not be given unless the quality of material therefrom is at least equal to the quality of material from the described source or sources. Generally deposits located within five hundred (500) feet of the centerline will not be approved.

On all contracts which involve the removal of material such as borrow, sand, gravel or rock, from property owned by other than the state or federal governments, the contractor shall secure a written release and satisfaction (in duplicate) from the material source owners. The release shall certify that the owner has been paid, that the pit or quarry site has been left in satisfactory condition and that the contractor and state are relieved from any liability arising from the removal of material. All releases shall be on standard release forms furnished by the department, a copy of which appears at the end of this section.

When described deposits are located on government lands and have been withdrawn by the state as shown on the Deposit Sketch by the withdrawal application number or by a use permit, the agreements mentioned above will not be required. If the contractor selects a deposit on government lands other than that designated, he shall determine the rules and regulations governing the use of such lands for the purposes intended and shall comply with such rules and regulations fully, securing all permits and paying all costs involved. The contractor shall furnish the engineer with certified copies of all permits obtained by him in this instance.

In case a described deposit fails to contain the quantity of acceptable material indicated in the special provisions, the contractor shall immediately notify the engineer in writing. The engineer shall thereupon investigate, and if his investigation shows that there is not a sufficient quantity of acceptable material, he shall designate an alternate deposit from which to obtain the deficit. In such case, an adjustment of compensation shall be made as provided in Article ~~9.8.~~ 9.7.

The contractor shall confine his operations to the areas and depths of material deposits shown on the plans or described in the special provisions. Should the contractor desire to extend the area or depth of a deposit, samples of material outside the designated limits must first be submitted and approved.

Sites from which material has been removed shall be left in a neat and presentable condition upon completion of the work, and all fences removed for the purposes of entry shall be replaced in as good a condition as they were before being removed.

On projects involving the hauling of material and equipment over public highways and streets, the contractor shall, at his expense, maintain and restore such roads and streets, over which his material and equipment are hauled, to a condition equally as good as that in which they were found when his hauling was started.

Dust nuisance, due to contractor's hauling operations on public highways, streets, and hauling roads to pits, shall be abated in a satisfactory manner by the application of water or other dust palliatives, at the contractor's expense.

The engineer shall be sole judge as to the condition of public highways and streets used in hauling, and as to the amount of material and labor required to maintain and restore said roads.

Check 7.9 page 36 last Paragraph
[illegible] the necessary right of way for.

The contractor shall be responsible for the construction of hauling roads to the pits.

6.3 Plant Inspection. (a) General. If the engineer deems it necessary or desirable, the engineer may inspect the production of the material or manufacture of the product at the sources of supply. Plant inspection, however, will not be undertaken until the engineer is assured of the cooperation and assistance of both the contractor and the material producer. The engineer and inspector shall have free entry at all times to such parts of the plant as concerns the manufacture or production of the materials ordered, and the material producer shall furnish free of charge all reasonable facilities to assist in determining whether the material furnished meets the requirements of the specifications. The engineer assumes no obligation to make the inspection of materials at the source of supply and the responsibility of securing satisfactory materials rests entirely with the contractor.

Should the engineer deem it advisable to furnish more satisfactory control of materials used in the manufacture of the product, the contractor or materials producer shall make the necessary arrangements to store specified quantities of specific materials in such a manner that the stored materials shall not be subject to contamination or adulteration.

The engineer reserves the right to re-test or re-inspect after delivery on the job all materials which have been accepted at the source of supply and to reject all materials which, upon re-test or re-inspection do not comply with the requirements of the specifications.

To permit sampling, testing, or inspection, the contractor shall give the engineer sufficient notice in advance regarding the placing of purchase orders.

(b) Bituminous Plant Inspection. For checking the adequacy and condition of the bituminous plant equipment, the operations of the plant, for the

verification of weights or proportions used in the mixes, for the determination and checking of temperatures, for the sampling of materials and to permit the complete inspection of the preparation of the mixes, the engineer shall have access to any and all parts of the plant used in preparing the mixes.

In addition to specific requirements described for plants used in the preparation of mixes of various types covered by the specifications, the contractor shall provide and maintain at the plant a sufficient number of accurate stationary and portable thermometers or other apparatus necessary to enable the inspector to have accurate knowledge of the temperatures of aggregates and bitumin during the process of mixing. The contractor shall also make the necessary arrangements to furnish the equipment necessary to enable the inspector to have accurate knowledge of the quantities of material used in the preparation of the mixes. The contractor shall assist the inspector in obtaining the necessary samples for the accurate control of materials at any point in the plant.

6.4 Samples and Tests. To ascertain if materials comply with specification requirements samples shall be taken in accordance with standard practices and as often as the engineer deems it advisable and necessary.

The contractor shall afford such facilities as the engineer may require for collecting and forwarding samples and shall not make use of or incorporate in the work any material represented by the samples until the tests have been made and the materials found to be acceptable in accordance with the requirements of the specifications. The contractor shall furnish without charge all samples required. Tests will be made by and at the expense of the department unless otherwise noted in these specifications in accordance with the most recent standard or tentative standard methods of AASHO or ASTM which are current on the date of the advertisement for bids and by such special methods and tests as are in use in the department laboratory. Samples shall be taken by a representative of the department. All materials being used are subject to inspection, test or rejection at any time during their preparation and use.

6.5 Special Methods of Tests. (a) Swell Test. The swell test shall be made by preparing a sample of dried aggregate of sufficient size to make a compacted cylinder four (4) inches in diameter and two (2) inches in height, proportioning the various sizes of aggregate to conform to grading requirements of the product desired. Asphaltic material of the grade to be used in construction is added in an amount equal to the theoretical quantity required by the aggregate. Aggregate and asphaltic material are heated to a temperature within the range of field mixing temperatures and are mixed until all particles are coated and the color is uniform. The molding apparatus consists of a metal cylindrical mold to the outer surface of which is attached a rod for supporting the measuring device, a close-fitting cylindrical plunger for compressing the sample, a machined metal base plate, and a hardwood tamping rod. The mold has an internal diameter of four (4) inches and is six (6) inches in height. While still warm, the prepared sample is placed in the mold in two layers. Initial compaction is obtained by rodding each layer twenty-five strokes with the tamping rod. Final compaction is obtained by inserting the plunger, placing the apparatus in a suitable testing machine and subjecting the sample to an ultimate load of one thousand (1000) pounds per square inch. After the mold with its contents has cooled to room temperature, the surface of the specimen is covered with distilled water to a depth of two and one-half (2-1/2) inches and, after a lapse of twenty-four (24) hours, any vertical expansion or swell is measured accurately to the nearest one-thousandth (0.001) inch.

(b) Stripping Test. A weighed sample of the material is mixed with approximately five (5) percent by weight of the asphaltic product proposed for use. If the asphaltic product is a liquid at normal atmospheric temperature, the mixture is then spread out in a thin layer and allowed to air season overnight.

A 50-gram sample of the mixture is separated as nearly as possible into individual fragments or small clumps and placed in 250 cc. Erlenmeyer flask with 175 cc. of distilled water.

The flask and contents are then agitated by rotation at a slow speed for a period of five (5) minutes at room temperature. At the end of this period the sample is examined for evidence of film stripping and the observation recorded.

If little or no stripping has been noted at room temperature, the test is repeated for another five (5) minute period at one hundred (100) degrees F., the water being maintained at the temperature by means of a water bath throughout the period of test.

If little or no stripping has been noted at one hundred (100) degrees F. the test is then repeated at one hundred twenty (120) degrees F.

The test is not quantitative in nature and observations as to extent of stripping may vary with individual operators. It is therefore suggested that the following general classification be adopted for reporting observations at the end of each period of agitation:

(1) No stripping.
(2) Slight stripping.
(3) Bad stripping.

If apparently twenty-five (25) percent or more of the surface area of the aggregate particles have been stripped, the results shall be reported as bad stripping.

(c) Residue of Emulsified Asphalt at Three Hundred and Twenty-Five (325) Degrees F. The procedure followed shall be in accordance with the Standard Method of Test for Loss of Heating of Oil and Asphaltic Compounds, AASHO T47, except that the determination of the residue shall be the average of three fifty gram samples heated for three (3) hours in a dish or beaker not less than three (3) inches in diameter and of sufficient depth to prevent overflow.

(d) Compaction Test. Maximum density shall be obtained from a series of compaction tests, each at a standard degree of compaction but at a different moisture content, plotting for each test the pounds of dry soil per cubic foot against its respective moisture content, and drawing a smooth curve through the resulting points. The peak of the curve represents the maximum density and the percentage of water at that point represents the optimum moisture.

The dry weight per cubic foot at a standard degree of compaction for a given moisture content shall be determined by oven drying a sample sufficient to fill the compaction cylinder to a height of ten (10) to thirteen (13) inches when compacted and thoroughly mixing with it the desired amount of water. Compaction is obtained by means of apparatus consisting essentially of a compaction cylinder three (3) inches in diameter, a tamping shaft weighing ten (10) pounds graduated in inches and tenths, and a piston. The moistened soil is placed in

the compaction cylinder in five approximately equal layers and each layer is consolidated by dropping the tamping shaft twenty times through a height of eighteen (18) inches. After the fifth layer is compacted, the piston is placed within the cylinder and given five additional blows of the tamping shaft. With the tamping shaft resting on the piston, the height of the compacting soil column is read from the figures on the graduated tamping shaft to the nearest one-tenth (1/10) inch at a point level with the top of the tube. The dry weight per cubic foot of the compacted soil may then be read from a prepared table.

The dry weight per cubic foot in place shall be obtained by excavating a test hole, carefully saving and weighing all excavated material, determining the moisture content, and determining the volume of the hole by refilling it with a dry sand of a known weight per cubic foot.

The relative compaction of a given soil shall be obtained by the following formula:

$$RC = \frac{WP}{WC} \times 100 \text{ in which}$$

RC = relative compaction
WP = dry weight per cubic foot in place, and
WC = maximum density or maximum dry weight per cubic foot compacted to a standard degree of compaction.

(e) Stability Tests of Asphaltic Mixtures. Stability tests are made in a stabilometer consisting of a cylindrical container in the form of a hydraulic cell arranged to measure the magnitude of any pressure tending to deform the specimen while the specimen is being subjected to load. Test specimens are prepared by compacting a sample of bituminous treated material to approximate road compaction, using the asphaltic material and grading of aggregate proposed for use on the construction in the form of briquettes four (4) inches in diameter and two and one-half (2-1/2) inches high. The mixture should include all particles passing the one (1) inch sieve. Compacted specimens are placed in the cylinder at a temperature of one hundred and forty (140) degrees F. and subjected to pressure at a standard testing press. The load is applied steadily to the specimen at a rate of five-hundredths (0.05) inch per minute, and the horizontal pressure transmitted through the specimen is measured by the magnitude of the expansion against the cylindrical hydraulic cell. Stability values are compared at a test load of four hundred (400) pounds per square inch. Stabilometer readings are reported as stability in a scale ranging from zero (0) percent to one hundred (100) percent in which the zero (0) percentage is material giving a stabilometer reading similar to that of a liquid, and one hundred (100) percent represents a solid giving no stabilometer reading under the applied load.

6.6 Field Laboratory. Where required by these specifications or by special provisions, the contractor shall provide, without extra compensation, a field laboratory or office in which to house and use the testing equipment. This building shall be constructed as detailed on the standard plan titled "Standard Field Laboratory". The building shall be so located that the details of the contractor's plant are in plain view and plainly visible from at least one window of the building. The building is to be used exclusively by the engineer. The windows and doors shall be provided with locks. It shall be maintained dust and water tight and have satisfactory lighting and heating equipment. When available, electrical connections shall be provided.

6.7 Storage of Materials. Materials shall be so stored as to insure the preservation of their quality and fitness for the work. When considered necessary they shall be stored in waterproof buildings, placed on wooden platforms or other hard, clean surfaces, and not on the ground, and shall be covered when directed. Stored materials, even though approved for use before storage, may be inspected prior to their use in the work, and they shall meet the requirements of the specifications at the time of this proposed use. Stored materials shall be located so as to facilitate their prompt inspection. That portion of the right of way not required for public travel may be used for storage purposes and for placing of the contractor's plant and equipment, but any additional space required therefor must be provided by the contractor at his expense. Private property shall not be used for storage purposes without written permission of the owner or lessee. All storage sites shall be restored to their original condition by the contractor at his expense. This shall not apply to the stripping and storing of top soil or to other material salvaged from the work or specifically prescribed under the specifications.

During the handling of all aggregates or other construction materials, special care shall be taken that no earth or foreign material becomes mixed therewith. Aggregates shall be handled in such a manner as to prevent segregation.

6.8 Defective Materials. All materials not conforming to these specifications shall be considered defective, and all such materials, whether in place or not, shall be rejected and shall be removed immediately from the site of the work unless otherwise directed by the engineer. No rejected material, the defects of which have been substantially corrected, shall be used until approval has been given. Upon failure on the part of the contractor to comply immediately with any order of the engineer made under the provisions of this article, the engineer shall have the authority to remove and replace the defective material and to deduct the cost of removal and replacement from any moneys due or to become due the contractor.

6.9 Handling Materials. All materials shall be handled carefully and in such manner as to preserve their quality and fitness for the work. They shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segration of materials after loading and measuring in order that there may be no inconsistencies in the quantities of materials intended for incorporation in the work as loaded, and the quantities as actually received at the place of operations.

6.10 Materials Inspection. In order to expedite the inspection and testing of materials the contractor shall advise the engineer at least fifteen (15) calendar days prior to delivery of materials from commercial sources of supply.

STANDARD FORM OF RELEASE

KNOW ALL MEN BY THESE PRESENTS:

That (I) (We) _____

_____

_____

for and in consideration of the sum of One Dollar ($1.00), and other good and sufficient consideration, to (Me) (Us) in hand paid, and/or received, have forever released and discharged, and by these means do forever release and discharge

_____

_____ of _____.
(Contractor) (City)

_____ and the State of Nevada, Department of Highways from all claims,
(State)

demands, and liability, joint or several, of any kind and nature whatsoever that (I) (We) have or may hereafter have, by reason of removal of earth, gravel, sand, rocks, and/or topsoil from (My) (Our) property during the performance of State of Nevada, Department of Highways, Contract No. _____, Project No. _____, on Highway (F.A.S.) (U.S.) (State) Route No. _____, _____ County, Nevada.

Dated: _____, 19____.

Witness:

_____ _____

_____ _____

_____ _____

_____ _____

SECTION 7 - LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

7.1 Laws to be Observed. (a) The contractor shall keep himself fully informed of all federal and state laws, all local bylaws, ordinances, and regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. He shall at all times observe and comply with all such laws, ordinances, regulations, orders and decrees and shall protect and indemnify the state and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order or decree whether by himself or his employees.

(b) Under the Federal Act which imposes a tax of three (3) percent on amounts paid for transportation of property by motor vehicle, rail, water or air, exemption from payment of the tax is allowed where property is transported to or from government of a state or other political subdivision, or an agency or instrumentality thereof, and the shipping papers show the consignor or consignee to be such an organization. In order that the state may benefit from the exemption thereby allowed, the Department of Highways hereby authorizes the contractor to whom this contract is awarded to have all shipments of materials destined to enter into the work covered by the contract and to become the property of the state, consigned to the State of Nevada, Department of Highways in care of the contractor, and to claim exemption from the transportation tax that would otherwise be imposed on such shipments.

This authority is granted to the contractor by the Department of Highways with the understanding that the saving to be made by the exercise of this exemption privilege will be reflected in the prices bid for the contract work and will in that manner accrue to the benefit of the state or other governmental agencies by which funds for the work are contributed.

Exemption from the transportation tax does not apply to shipments of fuel, lubricants, spare parts, equipment, plant, consumable supplies, construction forms, form lumber or other items which do not become a part of the completed work or which do not become the property of the state, and the contractor is not, by these provisions, authorized to use the name of the Department of Highways or the state of Nevada in the consignment of shipments of such items.

The contractor is cautioned that any misuse of the authority hereby granted, wherein shipments not eligible for exemption hereunder are consigned to the Department of Highways, thereby wrongfully relieving the contractor of an obligation to pay a transportation tax, is a violation of Federal law, subject to punishment as prescribed therein.

7.2 Permits, Licenses and Taxes. The contractor shall procure all permits and licenses, pay all charges and fees and give all notices necessary and incident to the due and lawful prosecution of the work.

7.3 Patented Devices, Materials and Processes. If the contractor is required or desires to use any design, device, material, or process covered by letters of patent or copyright, he shall provide for such use by suitable legal agreement with the patentee or owner, and a copy of this agreement shall be filed with the department; if no such agreement is made or filed as noted, the contractor and the surety shall indemnify and save harmless the state, any affected railroad or railway company, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the

state for any costs, expenses and damages which it may be obliged to pay by reason of any infringement at any time during the prosecution or after the completion of the work.

7.4 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street, or to grant permits for same, at any time, is hereby expressly reserved by the department for the proper authorities of the municipality, county or state as the case may be in which the work is done and the contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby.

Any individual, firm, or corporation, other than a party to this contract wishing to make an opening in the highway must secure a permit from the department and the contractor shall not allow any person or persons to make an opening unless a duly authorized permit of the department is presented. The engineer may authorize the contractor to allow parties bearing such permits to make openings in the highway. The contractor shall, when ordered by the engineer, make in an acceptable manner all necessary repairs due to such openings, and such necessary work shall be paid for as extra work as provided in these specifications, and shall be subject to the same conditions as original work performed.

7.5 Federal Participation. (a) Work Subject to Inspection and Approval of Federal Agency. When the United States Government pays all or any portion of the cost of the work, the Federal laws authorizing such participation and the rules and regulations made persuant to such laws, must be observed by the contractor. The work shall be subject to the inspection and approval of the authorized representatives of such Federal agencies as are created for the administration of these laws, but such inspection will in no sense make the Federal government a party to the contract and will in no way interfere with the right of either party hereunder.

(b) Fair Labor Standards Act. The attention of bidders is directed to the fact that this department has been advised by the Wage and Hour Division, U.S. Department of Labor, that contractors engaged in highway construction work are required to meet the provisions of the Fair Labor Standards Act of 1938 (52 Stat. 1060).

7.6 Sanitary Provisions. The contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necesaary to comply with the requirements and regulations of the Nevada State Board of Health or of other authorities having jurisdiction, and shall commit no public nuisance.

7.7 Public Convenience and Safety. The contractor shall at all times so conduct his work as to insure the least possible obstruction and inconvenience to public traffic, and he shall have under construction no greater length or amount of work than he can prosecute properly with due regard to the rights of the public. The convenience of the general public and the residents along the highway and the protection of persons and property are of prime importance and shall be provided for by the contractor in an adequate and satisfactory manner. When it is necessary for residents living along the project to use a portion of the road under construction, the contractor shall maintain, within the limits of these specifications, that portion of the road in a suitable condition for vehicular travel.

When it is indicated on the plans or provided in the special provisions that traffic shall be carried through construction the contractor shall provide and maintain suitable means for the movement of such traffic at all times.

The contractor shall at all times during the progress of the work or temporary suspension of the work, provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals, and signs, provide a sufficient number of flagmen, and take all necessary precautions for the protection of the work and safety of the public, and those engaged on the work. Signs and barricades shall conform to the standards shown on the plans or approved by the engineer. All barricades and obstructions shall be illuminated at night with reflectorized signs and lights, and all lights for this purpose shall be kept burning from sunset to sunrise.

The safety and convenience of the general public and the residents along the highway, and the protection of persons and property, shall be provided for by the contractor as specified under Section 11.

7.8 Relations With Railroad on Railroad-Highway Grade Separations, Railroad Crossings, Operations on Railroad Property. (a) Definitions: The following definitions shall apply to the terms as herein used. Railroad: The railway or railroad company whose tracks are crossed or whose property is adjacent to the work or upon whose property the work is performed. Chief Engineer: The Chief Engineer of the railroad or his authorized representatives. Railroad Crossing: A crossing at grade of the tracks of a railroad and the highway. Grade Separations: A permanent structure to affect the separation of grades between the highway and the railroad.

(b) Work or Operations: (1) Work or operations on grade separations, railroad crossings, or upon railroad property shall be subject to inspection by the Chief Engineer, and shall be conducted and performed in a manner satisfactory to the Chief Engineer.

(2) Construction operations shall be so arranged and conducted as to insure safe and uninterrupted operation of the railroad traffic. The contractor shall be responsible for any damages which result either directly or indirectly from contractor's operations.

(3) The contractor shall notify the Chief Engineer in writing, at least forty-eight (48) hours before starting any work in the proximity of the tracks, setting forth specifically the time at which it is planned to start such work.

(4) Unless otherwise provided, the contractor shall not pile or store any material, or park or use contractor's equipment closer than ten (10) feet from the centerline of the tracks.

(5) The track zone shall be kept clean of all loose material or debris at all times. The contractor shall be responsible for any fouling of railroad ballast resulting from sandblasting and painting operations and shall reimburse the railroad for the replacement of all ballast so fouled.

(6) In advance of any blasting, the contractor shall notify the Chief Engineer in order that proper flagging protection may be provided by the railroad. Excavations in the proximity of the tracks shall be sheeted in a manner satisfactory to the Chief Engineer and plans therefor shall be submitted to and approved by him before any such excavation is commenced.

(7) The contractor shall make arrangements with the railroad for crossing railroad tracks at locations other than existing public crossings and shall bear all costs incident thereto.

(8) The contractor shall submit detail plans of falsework, and of forms for track spans and piers or abutments, to the Chief Engineer and no work thereon shall be commenced unlessaand until such plans have been approved by the Chief Engineer. The temporary vertical and horizontal clearances specified by the Chief Engineer in approving the plans shall be maintained at all times. In the case of impaired vertical clearances above the top of rail, the railroad shall have the option to install telltales, or such other protective devices the railroad deems necessary, for protection of trainmen or rail traffic.

(9) The contractor shall comply with the rules and regulations of the railroad with respect to the contractor's work or operations on or adjacent to railroad property. The contractor shall arrange with the railroad for the services of such qualified railroad employees as the Chief Engineer may prescribe to protect and safeguard the railroad's property, engines, trains and cars. The costs incurred for the services of such railroad employees as may be prescribed by the Chief Engineer for necessary safeguard and protection and the costs of installing telltales or other protective devices in the case of impaired vertical clearance, shall be borne by the contractor without expense to the department or railroad. Payment for such services, including compensation insurance, vacation and holiday time, railroad retirement and unemployment taxes, health and welfare, accounting and billing charges, shall be paid by the department directly to the railroad and the amounts thereof shall be deducted by the department from moneys due or which may become due the contractor under the awarded contract. Rates of pay for qualified railroad employees will be the railroad's rates for the various classes of labor customarily used and in effect at the time the work is performed. The contractor's reimbursement for personnel and protective devices required as set forth herein shall be considered as included in the contract unit prices bid for other items of work.

(10) Upon completion of the work covered by the awarded contract to be performed by the contractor upon railroad's property, the contractor shall promptly remove from the railroad's property all tools, equipment and other materials, whether brought upon said property by the contractor or any subcontractor, and shall cause said property to be left in a clean and presentable condition.

(c) Work or Operations Performed by Railroad: The railroad may undertake certain work or operations incident to the project which are the subject of an agreement between the department and railroad. Details of such work or operations will be set forth in the special provisions and the contractor shall discuss such items with the Chief Engineer in order to develop a plan whereby the contractor and the railroad accomplish the work or operations in their logical sequence and order.

Movement or adjustment of telephone, telegraph or signal facilities owned, operated or maintained by the railroad and not otherwise provided for on the plans or in the special provisions shall be at the cost and expense of the contractor.

(d) Insurance: The contractor shall provide and maintain during the effective life of the awarded contract such special or additional insurance as is required by Article 7.12 herein. The contractor shall furnish such evidence as may be required that such insurance has been provided.

(e) As a prerequisite to award, the contractor shall be satisfactory as to responsibility to perform work upon the railroad's property.

(f) The provisions of Article 7.8, Article 7.12, and the special provisions shall inure directly to the benefit of the railroad.

7.9 Protection and Restoration of Property and Landscape. The contractor shall be responsible for the preservation from injury or damage resulting directly or indirectly from the work under his contract of all public and private property, crops, trees, vegetation, monuments, fences, highway signs and markers, etc., along and adjacent to the highway, and shall use every precaution necessary to prevent damage to pipes, conduits, and other underground structures, to poles, wires, cables, and other overhead structures, whether shown on the plans or not, shall protect carefully from disturbance or damage all land monuments and property marks until the engineer has witnessed or otherwise referenced their location, and shall not remove them until directed. The contractor shall not willfully or maliciously injure or destroy trees or shrubs and he shall not remove or cut them without proper authority.

He shall be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect or misconduct in his manner or method of executing said work, or at any time due to defective work or materials, and such responsibility shall not be released until the project shall have been completed and accepted.

The contractor shall be responsible for the preservation of archeological and paleontogical objects, including all ruins, sites, buildings, artifacts, fossails or other objects of anituqity encountered during construction. When such objects are encountered, the contractor shall immediately cease operations and notify the engineer that such objects exist. Construction operations shall be rescheduled to avoid the section until the removal of the artifacts or the gathering of historical data has been accomplished by the appropriate authority. No additional compensation will be allowed for any delays, inconvenience or damages sustained by the contractor due to interference from the said archeological and paleontological objects being located within the construction area or from the operation of moving them.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution thereof on part of the contractor, he shall restore at his own expense such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner. In case of failure on the part of the contractor to restore such property or make good such damage or injury, the engineer may, upon forty-eight (48) hours written notice, proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof shall be deducted from any moneys due, or which may become due the contractor under the contract.

Prior to constructing haul roads across publicly or privately owned lands, the contractor shall reach an agreement with the owners of the land or with the agency of the United States Government having jurisdiction over such lands relative to the location of the roads. He shall also reach an agreement with such agency having jurisdiction over public lands as to the location and eventual disposal of any wells he may drill in connection with this contract. In areas subject to the spread of halogeton he shall take all reasonable care during the course of construction of the project to avoid any unnecessary disturbance of soil or vegetation within the right-of-way, along haul roads or at pit sites from which material has been obtained.

7.10 Use of Explosives. When the use of explosives is necessary for the prosecution of the work, the contractor shall exercise the utmost care not to endanger life or property. The contractor shall be responsible for any and all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with local laws and ordinances, and all such storage places shall be marked clearly "DANGEROUS EXPLOSIVES". Where no local laws or ordinances apply, storage shall be provided satisfactory to the engineer and in general not closer than one thousand (1000) feet from the road or from any building or camping area.

The contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives, and such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury. Such notice shall not relieve the contractor of responsibility for any damage resulting from his blasting operations.

7.11 Responsibility for Damage Claims. The contractor shall indemnify and save harmless the department, its officers and employees from all suits, actions, or claims of any character brought because of any injuries received or sustained by any person, persons, or property on account of the operations of the said contractor, or through use of unacceptable materials in constructing the work, or because of any act or omission, neglect or misconduct of said contractor, or because of any claims or amounts recovered from any infringements of patent, trademark or copyright, or from any claims or amounts arising or recovered under the "Nevada Industrial Insurance Act" or any other law, ordinance, order or decree; and so much of the money due the said contractor under and by virtue of his contract as shall be considered necessary by the department for such purpose may be retained for the use of the state, or, in case no claim or claims, injuries or damages as aforesaid shall have been settled, and suitable evidence to that effect furnished to the department; except that money due the contractor will not be withheld when the contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

Reimbursement to the contractor by the state in whole or in part for costs of protecting traffic shall not serve to relieve the contractor of his responsibility as set forth in these standard specifications.

The contractor guarantees the payment of all just claims for materials, supplies, and labor, and all other just claims against him or any subcontractor, in connection with this contract.

7.12 Liability Insurance. (a) Contractor's Public Liability and Property Damage Liability Insurance. The contractor shall provide and maintain during the effective life of the awarded contract, regular Contractor's Public Liability and Property Damage Liability Insurance to protect the contractor and all of the contractor's construction subcontractors for claims for personal injury, accidental death, and to property, which may arise from operations under said contract, whether such operations be by the contractor or by such subcontractor or by anyone directly or indirectly employed by either of them.

Whenever construction operations covered under said contract are to be performed upon or in proximity to railroad property, the Contractor's Public Liability and Property Damage Insurance shall provide for limits of coverage not less than specified in the "Railroad Protective Insurance Endorsement" appended to the special provisions.

(b) Railroad's Protective Public Liability and Property Damage Insurance. In all cases where construction operations covered by the awarded contract are to be performed upon or adjacent to the property of the railroad, the contractor shall furnish evidence to the department that, with respect to the operations the contractor or any of the contractor's subcontractors perform, the contractor has provided for and in favor of the railroad a policy of Public Liability and Property Damage Insurance, to which is attached an endorsement, in the same form and with the same limits of coverage as the "Railroad Protective Insurance Endorsement" appended to the special provisions.

(c) General. The insurance required under paragraph (b) above shall apply only to that portion of the highway project upon or adjacent to the railroad property.

Railroad's Protective Public Liability and Property Damage Insurance shall be subject to approval by the railroad before any work is commenced on or adjacent to the railroad property.

Such insurance shall be carried, and the premiums therefor paid, by the contractor until all work, required to be performed under the terms of said contract, is satisfactorily completed as evidenced by the formal acceptance of the department and thereafter until all of said tools, equipment and materials have been removed from the property of the railroad and such property left in a clean and presentable condition. The insurance shall be non-cancellable and non-alterable for any cause whatsoever (including failure to pay premiums) either by the contractor or by the insurance company without thirty (30) days' written notice to the railroad and the department. In the event such insurance is cancelled as herein provided, the contractor shall provide other insurance, subject to the same conditions as provided herein, which shall be effective as of the day of such cancellation and shall cover the unexpired period of the term herein required. The contractor shall furnish the department at the time of execution of said contract three copies of each policy to which is attached an endorsement the same as the "Railroad Protective Insurance Endorsement" appended to the special provisions. Two copies of each of such policies shall be forwarded by the department to the Chief Engineer for the railroad's approval.

7.13 Opening Sections of Project to Traffic. At the option of the engineer certain sections of the work may be inspected and the completed work tentatively accepted for the use of traffic. Such acceptance shall not constitute final acceptance of the work or any part of it, or a waiver of any provisions of the contract; provided, however, that on such portions of the project as are accepted for use of traffic, the contractor shall not be required to assume any expense entailed in maintaining the roadway for traffic as a result of ordinary wear and tear after such acceptance, but shall be compensated therefor in the manner provided hereafter in Article 9.4. Any damage to the highway that may occur on such section not attributable to traffic shall be repaired by the contractor at his expense, provided, however, that any unavoidable "slides" shall be removed and paid for at the respective contract unit prices for the quantities and items of work involved.

If the contractor is dilatory in completing shoulders, drainage structures or other features of the work, the engineer may order all or a portion of the project opened to traffic, but in such event the contractor shall not be relieved of his liability and responsibility during the period the work is

so opened prior to final acceptance. The contractor shall conduct the remainder of his construction operations so as to cause the least obstruction to traffic.

In the case of a contract for the placing of a surface course or courses upon a subgrade previously constructed under a separate contract, the contractor shall be required to maintain the subgrade ahead of other operations covering the preparation and condition of the subgrade.

7.14 Contractor's Responsibility for Work. Until final acceptance of the work by the engineer as evidenced in writing, the contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work. Unless otherwise provided for in these specifications, the contractor shall rebuild, repair, restore and make good, without extra compensation, all injuries or damages to any portion of the work occasioned by any of the above causes before its completion and acceptance, except damage to the work due to unforeseeable causes beyond the control of, and without fault or negligence of the contractor, including, but not restricted to acts of God, of the public enemy, or of state or governmental authorities, slides found by the engineer to have been unavoidable and ordinary wear and tear on any section of the road accepted for maintenance.

In case of suspension of the work from any cause whatever, the contractor shall be responsible for all materials, and shall properly store them, if necessaary, and shall provide suitable drainage of the roadway and erect necessary temporary structures at his expense.

7.15 Contractor's Responsiblity for Public or Private Utility Properties and Services. At points where the contractor's operations are adjacent to properties of railroad, telegraph, telephone, and power companies, or are adjacent to other property, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The contractor shall not begin any operations which may interfere with or impair the normal service being rendered by public or private utility operators, until such operators have been notified, and shall cooperate with the owners of any underground or overhead utility lines in their removal and re-arrangement operations in order that these operations may progress in a reasonable manner, and that duplcation of re-arrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. The contractor will be held responsible for the protection of the property or service of public or private utilities within the limits of the work.

In general the repair and adjustments of street structures, such as pipe lines, services, telephone, telegraph, and electric lines, above or below the ground, will be made by the owners thereof. When included in the proposal, the adjustment of sewer manhole frames and covers, inlet and catch basin frames, covers, and the like, will be within the contractor's responsibility that they are adjusted to conform to the lines, grades, and typical cross-section as shown on the plans, or as prescribed, without respect to whether the repairs and the roughing-in work have been performed by the contractor or others.

Pipes or other construction shall be maintained in continuous service and shall be properly protected and supported. In no case shall interruption of the water service be allowed to exist outside of working hours.

Fire hydrants shall be accessible at all times to the fire department. No material or other obstruction shall be placed closer to a fire hydrant than permitted by ordinances, rules, or regulations, or within fifteen (15) feet of the fire hydrant in the absence of such ordinances, rules, or regulations.

The contractor shall give notice in writing to the proper authorities in charge of streets, gas, water pipes, electric, and other conduits, railroads, poles, manholes, catch basins, and all other property that may be affected by the contractor's operations, at least forty-eight (48) hours before breaking ground.

In the event of interruption to water or utility services as a result of accidental breakage, the contractor shall promptly notify the proper authority. He shall cooperate with the said authority in the restoration of service as promptly as possible.

7.16 Personal Liability of Public Officials. In carrying out any of the provisions of these specifications or in exercising any power or authority granted to them by or within the scope of the contract, there shall be no liability upon the directors, engineer, or their authorized representatives, either personally or as officials of the state, it being understood that in all such matters they act solely as agents and representatives of the state.

7.17 No Waiver of Legal Rights. The department shall not be precluded or estopped by any measurements, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefor, from showing the true amount and character of the work performed, and materials furnished by the contractor, nor from showing that any such measurements, estimate, or certificate is untrue or is incorrectly made, nor that the work or materials do do not in fact conform to the contract. The department shall not be precluded or estopped, notwithstanding any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the contractor or his sureties or both such damages as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the department, nor any representative of the department, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the department shall operate as a waiver of any portion of the contract, or of any power herein reserved, or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

7.18 Fire Prevention and Control. Before setting any fires whatsoever, the contractor shall notify the responsible Federal or state agency having jurisdiction for the area concerned. All burning shall be done at night unless otherwise authorized in writing by the engineer. The contractor shall abide by such rules and instructions as to fire prevention and control and as to the place for burning as the Forest Service, Bureau of Land Management, State Forester-Fire Warden or other Federal or state agency having jurisdiction may prescribe. The contractor shall take all necessary steps to prevent his employees from setting fires not required in the construction of the project, shall be responsible for preventing the escape of fires set in connection with construction of the project and shall under the direction of the appropriate Federal or state agency, or, in the absence of an officer from any such agency, acting independently, extinguish all fires set or caused by his employees and all other fires which may escape the project, whether or not set directly or indirectly as a result of construction

operations, without expense to the state or Federal government. Where the contractor is obligated to suppress any fire without expense to the state or Federal government under the provisions of this article if the amount and character of labor, subsistence, supplies and transportation which the contractor is in a position to furnish promptly for fire suppression prove inadequate for that purpose, in the judgment of the Federal or state agency in charge, then the appropriate officer of such agency is authorized to procure and to charge to the contractor, such additional labor, subsistence, supplies and use of transportation facilities as he may deem necessary for the suppression of the fire. These expenses shall be billed to the contractor for payment directly by him, and if not promptly met by him shall be paid by the Federal or state government and deducted from the moneys due or which may become due the contractor under this contract, or collected from his sureties until the entire amount due the Federal or state government for said fire suppression is recovered.

The contractor shall maintain a fire patrol in the vicinity of blasting and other operations creating a fire hazard. When in the opinion of the Federal or state agency having jurisiction, such a patrol is unnecessary because of weather conditions, the contractor shall be so notified through the engineer.

SECTION 8 - PROSECUTION AND PROGRESS

8.1 Subletting and Assignment of Contract. The contractor shall perform, with his own organization, work amounting to not less than fifty (50) percent of the combined value of all items of the work covered by the contract for each project except:

(a) Any work under the contract which requires highly specialized knowledge, craftsmanship, or equipment not ordinarily available in contracting organizations qualified to bid on the project may be designated and shown in the special provisions. These items, so designated, may be performed by subcontract without regard to the above limitations;

(b) If any bidder shall state in his proposal, the particular item or items of work which he proposes to sublet, and shall name therein the subcontractor to whom he proposes to sublet such work if an award is made to the bidder, such item or items of work may be performed by the main subcontractor, if approved, notwithstanding the fifty (50) percent limitation above specified, provided, the subcontractor named is a contractor in recognized standing, has a satisfactory performance record, and the work proposed to be sublet does not constitute the major item or items of work embraced in the contract.

Any bidder who shall name a subcontractor in his proposal shall attach thereto a certificate that the use of the subcontractor's name was with his knowledge and consent. The subcontractor, so named, may be required to submit questionnaires to establish his experience and financial ability, but for any subcontract for more than five thousand (5000) dollars, the subcontractor must be prequalified as required by law.

The naming of a subcontractor in a proposal will not necessarily insure approval of subletting work to him. In case of disapproval, the contractor shall perform such item or items of work with his own organization, in full compliance with all applicable terms of his contract.

No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the engineer.

Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing and accompanied by a letter showing that the organization which will perform the work is particularly experienced for such work. The contractor shall give assurance that the minimum wage for labor as stated in his proposal shall apply to all labor performed on all works sublet, assigned, or otherwise disposed of in any way.

Consent to sublet, assign or otherwise dispose of any portion of the contract shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract.

Roadside production of materials is construed to be production of crushed stone, gravel, and other materials with portable or semi-portable crushing, screening, or washing plants established or reopened in the vicinity of the work for the

purpose of supplying materials to be incorporated into the work on a designated project or projects and in all cases, unless performed by the contractor, shall be considered as subcontracting.

The purchase of sand, gravel, crushed stone, crushed slag, batched concrete aggregates, ready-mixed concrete, and any other materials produced at and furnished from established and recognized commercial plants, together with the delivery of such materials to the site of the work by means of vehicles owned or operated by such plants or by recognized commercial hauling companies, shall not be considered as subcontracting under these provisions.

Except as hereinafter stated, all hauling of materials from roadside production sources, or from railroad or commercial truck delivery points, to batching plants, mixing plants, or directly to their place of use in the road, and all hauling of materials from batching plants and mixing plants to their place of use in the road, unless done by the contractor's own equipment or recognized commercial hauling companies shall be considered as subcontracting under these provisions.

If batching plants or mixing plants are set up at rail or commercial truck delivery points and material in part supplied to such plants by rail or commercial truck transportation companies, the remaining materials required at such batching or mixing plants may be hauled to such plants without such hauling being considered as subcontracting.

8.2 Notice to Proceed. An official "Notice to Proceed" specifying the date by which construction operations shall be started will be issued to the contractor by the engineer. Work shall be commenced not later than the date set forth in the "Notice to Proceed" which in no case shall be less than twenty (20) days after the date of issuance of the "Notice to Proceed". Commencement of the work by the contractor shall be deemed and taken as a waiver of such notice on his part, but in such case he shall notify the engineer in writing at least forty-eight (48) hours in advance of the date on which he expects to begin the work. In no case, however, shall the contractor begin work prior to the date of approval of the contract. Contract time will begin on the date specified in the "Notice to Proceed", unless operations begin at an earlier date, in which case the date that such operations were begun will apply.

8.3 Prosecution of the Work. The work shall be prosecuted diligently at such rate and with such materials, equipment, labor and supervision as is considered necessary to insure its completion within the time set forth in the proposal. When so ordered by the engineer the contractor shall immediately provide such additional equipment, supplies and labor as may be deemed necessary to complete the work within the required time.

At any subsequent suspension and resumption of issuance of work, the contractor shall notify the engineer, in writing, at least forty-eight (48) hours before beginning actual operations.

8.4 Limitation of Operations. The contractor shall begin work at such points as the engineer may direct and shall thereafter prosecute the work at such points and in such order as may be prescribed from time to time by the engineer as will insure the least interference with traffic; and he shall, when directed by the engineer, make use of convenient detours.

When, in the judgment of the engineer, the contractor has initiated construction on a greater portion of the work than is necessary for the proper prose-

cution of the same, or is carrying on operations to the prejudice of work already started, the engineer may require the contractor to finish the portion on which work is in progress before additional portions are started.

No productive work shall be performed on Sundays or state recognized holidays; nor will the department require productive work to be performed on Saturdays. However, if the contractor elects to work on Saturdays, those Saturdays worked will be charged as working days. The contractor shall give the engineer notice of his intention to work on a Saturday at least forty-eight (48) hours in advance of such work. State recognized holidays are enumerated in Article 1.25 of these specifications.

The engineer is authorized to require the contractor to cease construction operations the day before and the day after said holidays if the contractor's operations are of such nature, the project is so located and traffic is of such volume that it is deemed expedient to do so.

The contractor shall so arrange his work and dispose of his material as not to interfere with the operations of other contractors engaged upon adjacent work, shall join his work to that of others in a proper manner and in accordance with the spirit of the plans and specifications, and shall perform his work in proper sequence in relation to that of other contractors, all as may be directed by the engineer. Each contractor shall be held responsible for any damage done by him or his agents to the work performed by another contractor. Each contractor shall so conduct his operations and maintain the work in such condition that adequate drainage shall be in effect at all times.

8.5 Character of Workmen, Methods and Equipment. The contractor shall employ only competent and efficient superintendents, foremen, and workmen, and whenever, in the opinion of the engineer, any employee is careless or incompetent, or obstructs the progress of the work or acts contrary to the instructions or conducts himself improperly to such an extent as to be obnoxious, the contractor shall, upon the request of the engineer, discharge or otherwise remove him from the work and shall not employ him again on the work except with written consent of the engineer.

The working force, methods, equipment, and appliances used on the work shall be such as will produce a satisfactory quality of work and shall be adequate to complete the contract within the time limit specified. All equipment, tools, and machinery used shall be maintained in a satisfactory working condition. The equipment also shall meet specific requirements set forth elsewhere in the specifications for performing certain items of work.

Should the contractor fail to remove such person or persons as required above, or fail to furnish suitable or sufficient machinery, equipment, or force for the proper prosecution of the work, the engineer may withhold all estimates which are due or may become due until his orders are complied with or may suspend work until such orders are complied with.

No convict labor shall be employed and no materials manufactured or produced by convict labor shall be used in connection with the work. This provision shall not be construed as applying to convicts on parole or probation.

The contractor shall not discriminate against any workmen because of race, creed, color, or national origin.

8.6 Temporary Suspension of the Work. The engineer shall have the authority to suspend the work wholly or in part by written order, for such period as he may deem necessary due to unsuitable weather, or to conditions considered unfavorable for the suitable prosecution of the work, or due to failure on the part of

the contractor to correct conditions unsafe for workmen or the general public, or due to failure to carry out orders given, or due to failure to perform any provisions of the contract. The contractor shall immediately respect the written order of the engineer to suspend the work wholly or in part. The contractor shall not suspend the work without permission of the engineer.

The work shall be resumed when conditions are favorable or deficiencies have been corrected as ordered or approved in writing by the engineer.

No allowance of any kind will be made for suspension of work by order of the engineer except as provided in Article 8.8.

8.7 Progress Schedule. On bridge contracts, within fifteen (15) days after award of contract, the contractor shall furnish the engineer with a progress schedule, prepared on the form issued by the department, showing in detail the estimated time of completion of the various parts of the structure.

When required in the special provisions the contractor shall submit, within fifteen days after award of contract, a progress schedule on the form issued by the department, showing the proposed order of work and indicating the time required for the completion of the major items of work. This working schedule shall be used as a basis for establishing major construction operations and as a check on the progress of the work.

8.8 Determination and Extension of Contract Time. The contract time for completion will be fixed by the department, and will be stated in the special provisions, either as a calendar date or based on a number of working days.

The contractor shall perform the work in an acceptable manner within the time stated in the contract except that the contract time for completion shall be adjusted as follows:

(a) If satisfactory completion of the contract shall require performance of work in greater quantities than those set forth in the proposal, the time allowed for performance shall be increased in the same ratio as the final estimate bears to the contract amount, and by such amounts as may be allowed under supplemental agreements and contract change orders as provided in Article 4.3 and extra work in Article 4.4.

(b) In case of suspension of major items of work by order of the engineer and through no fault of the contractor, the time for completion shall be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(c) When delays occur due to unforeseen causes beyond the control and without the fault or negligence of the contractor, including, but not restricted to, acts of God, acts of the public enemy, acts of the Government, fires, floods, epidemics, strikes, and freight embargoes, the time for completion shall be extended an amount determined by the engineer to be equivalent to the delays; provided, however, written request for such extension of time is made by the contractor within ten (10) calendar days

after the beginning of such delay. No allowance shall be made for delay or suspension of the work due to fault of the contractor.

The contract time shall begin as set forth in Article 8.2. When the final acceptance has been duly made by the engineer as prescribed in Article 5.13 the daily time charge shall cease.

8.9 Failure to Complete Work on Time. Time is an essential element of the contract and it is important that the work be pressed vigorously to completion. The cost to the department of the administration of the contract, including engineering, inspection, supervision, and other items, and inconvenience to the public, will be increased as the time occupied in the work is lengthened.

Should the contractor fail to complete the work within the time agreed upon in the contract or within such extra time as may have been allowed by extensions, there shall be deducted from any money due or that may become due the contractor, the sum set forth in the special provisions for each working day that the work shall remain uncompleted. This sum shall be considered and treated not as a penalty but as liquidated damages due the state, from the contractor by the reasons given above, which have caused an expenditure of public funds resulting from his failure to complete the work within the time specified in the contract. Due account shall be taken of any adjustment of the contract time for the completion of the work granted under the provisions of Article 8.8.

8.10 Default and Annulment of Contract. If the contractor fails to begin the work under the contract within the time specified in the "Notice to Proceed", or fails to perform the work with sufficient workmen and equipment or with sufficient materials to insure the completion of said work within the specified time, or shall perform the work unsuitably, or shall neglect or refuse to remove materials or perform anew such work as may be rejected as defective and unsuitable, or shall discontinue the prosecution of the work, or shall fail to resume within a reasonable time after notice to do so, work which has been discontinued, or if the contractor shall become insolvent or be declared bankrupt, or to commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of five (5) days, or shall make an assignment for the benefit of creditors, or if the contractor is determined to be in violation of the provisions of the contract relative to hours of labor, wages, character, and classification of workmen employed, or from any other cause whatsoever or shall not carry on the work in an acceptable manner, the engineer shall give notice in writing to the contractor and his surety of such delay, neglect, or default, specifying the same.

If the contractor or surety within a period of ten (10) days after such notice, shall not proceed in accordance therewith, then the engineer shall have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the contractor. The engineer may at his option call upon the surety to complete the work in accordance with the terms of the contract; or he may take over the work, including any or all materials and equipment on the ground as may be suitable and acceptable, and may complete the work by force account, or may enter into a new agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as, in his opinion, will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the department, together with the cost of completing the work under contract, shall be deducted from any money due or which may become due said contractor. In case the expense so incurred by the department shall be less than the sum which would have been payable under the contract if it had been completed by said contractor, then said contractor shall be entitled to receive the difference, and in case such expense shall exceed the sum which would have been payable under the contract, then the contractor and his surety shall be liable and shall pay to the state the amount of said excess.

8.11 Termination of Contractors Responsibility. Whenever the improvement contemplated and covered by the contract shall have been completely performed on the part of the contractor and all parts of the work have been approved and accepted by the engineer, according to the contract, and the final estimate paid, the contractor's obligation shall then be considered filled except as set forth in his bond.

SECTION 9 - MEASUREMENT AND PAYMENT

9.1 Measurement of Quantities. The measurement and determination of the number of units of each pay item will be made in general as prescribed hereinafter and specifically as set out under Method of Measurement and Basis of Payment in the specification of each pay item.

After the items of work are completed and before final payment is made therefor, the engineer will determine the quantities of the various items of work performed, as the basis for final settlement for all other than lump sum contracts. In the case of unit price items, the contractor will be paid for the actual amount of work performed in accordance with these specifications, as shown by the final measurements.

Actual authorized quantities of work satisfactorily completed under the contract, shall be measured by the engineer in accordance with United States standard measures, and well recognized engineering practices. Unauthorized wastings of material will be deducted and only such quantities as are actually incorporated in the completed work willlbe included in the final estimate.

All longitudinal measurements for area of subgrade, base courses, surface courses, pavement, and shoulders shall be made horizontally, and not along the actual surface of the roadway, and no deduction shall be made for fixtures in the roadway having an area of nine (9) square feet or less. For all transverse measurements for area of subgrade, base courses, surface courses, pavements, and shoulders, the dimension to be used in calculating the pay area shall be the neat dimension shown on the plans or ordered in writing by the engineer. Structures shall be measured according to the neat lines shown on the plans or as ordered in writing, and unless otherwise provided for in the special provisions.

No payment will be made for unauthorized excavation. Excavation or embankment beyond the required neat lines or slope stakes will not be measured for payment except as elsewhere provided herein and when within reasonable tolerances established by the engineer.

In computing volumes of excavation, embankment, and borrow, the average end area method will be used, unless otherwise specified.

All items which are measured by the linear foot, such as pipe culverts, underdrains, guard rail, etc., shall be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans.

The term gauge when used in the connection with the measurement of plates, shall mean the U.S. Standard Gauge, except that when reference is made to the measurements of galvanized sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, the term gauge shall mean that specified in the AASHO Designation: M36 for corrugated metal culvert pipe.

When the term gauge refers to the measurements of wire, it shall mean the wire gauge specified in the ASTM Designation: A82 for cold drawn steel wire for concrete reinforcement.

The term ton shall mean the short ton consisting of two thousand (2000) pounds avoirdupois. All materials which are specified for measurement by the ton shall be weighed on accurate, approved, scales set at locations designated by the engineer. All materials shall be weighed on platform scales, except as noted below and except that aggregate for gravel base courses, aggregate for roadmix or plantmix surfaces, selected material surface, and selected borrow may be weighed on batch scales mounted below the bunkers. All scales shall be furnished by and at the expense of the contractor, and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. Platform scales shall be of sufficient size and capacity to weigh, in one operation, the entire loaded vehicle, except that this requirement may be waived by the engineer to permit use of special hauling equipment with a wheel base longer than the commonly used platform scales. Waiver of this requirement, if made, shall be in writing and subject to such conditions as the engineer deems necessary to insure sufficiently accurate weights.

Platform scales shall be equipped with weatherproof housing so constructed as to protect the recording device and permit the weighmaster convenient access to all beams and dials. The housing shall not be less than eight (8) feet wide, ten (10) feet long, and seven (7) feet high, and shall have two windows, one facing the scales, and shall be equipped with a shelf at least two (2) feet wide and six (6) feet long.

If material is shipped by rail, the car weight may be accepted, provided the actual weight of material only will be paid for, and not minimum car weight used for excessive weight tarriff. Trucks, of a type and size satisfactory to the engineer, used to haul material being paid for by weight, shall be weighed empty daily at such times as the engineer directs, and each truck shall bear a plainly legible identification mark.

Timber will be measured by the thousand feet board measure (Mfbm) actually incorporated in the structure with no allowance for any waste except beveled ends. Measurement will be based on nominal widths and thicknesses, and the extreme length of each piece.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

All materials for which measurements are obtained by the cubic yard "loose measurement" or "measured in the vehicle" shall be hauled in approved vehicles and measured therein and at the point of delivery. No allowance will be made for the settlement of material in transit. Vehicles, for this purpose may be of any size or type acceptable to the engineer, provided that the body is of such shape that the actual delivered contents may be readily and accurately determined and will remain constant. Unless all approved vehicles on the work are of uniform capacity, each vehicle must bear a plainly legible identification mark, indicating its specific approved capacity. All vehicles must be loaded to at least their water-level capacity, and all loads shall be leveled when the vehicles arrive at the point of delivery. Loads not hauled in approved vehicles or of a quantity less than the specific approved quantity for the hauling vehicle, will be subject to rejection and no compensation will be allowed for the hauling of the material.

All bituminous material shall be measured by the gallon or ton as called for in the proposal. Each railroad tank, tank truck, or distributor tank of bituminous material delivered for the project shall be measured. The measurements

shall be taken when the bituminous material is of uniform temperature and free from air bubbles. Unless otherwise directed, the contractor shall furnish the engineer with certified calibrations of tank cars, distributor tanks, and tank trucks in which bituminous materials are delivered or stored.

The volumetric measurement of the bituminous material for these specifications will be based upon a temperature of sixty (60) degrees F. Reference is made to Section 33 of these specifications.

Only the quantity of bituminous material actually placed in the work and accepted will be considered in determining the amount due the contractor.

Rental of equipment will be measured by time in hours of actual working time and necessary travel time of the equipment within the limits of the project.

Material wasted or disposed of in a manner not called for, under the contract, material not unloaded from the transporting vehicle, material placed outside of the limits indicated on the plans or given, or material remaining on hand after completion of the work will not be paid for except as otherwise provided.

9.2 Scope of Payment. Payments to the contractor will be made for the actual quantities of contract items performed in accordance with the plans and specifications, and, if upon completion of the construction, these actual quantities show either an increase or decrease from the quantities given in the bid schedule, the contract unit prices will still prevail, except as provided in Article 9.4.

The contractor shall accept the compensation, as herein provided, in full payment for:

(a) The work complete, including all supervision, labor, materials, tools, equipment and incidentals necessary for all work contemplated and embraced under the contract;

(b) Any loss or damage due to the nature of the work, the action of the elements, strikes or lockouts;

(c) Accidents to employees or the public, or both;

(d) Unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work;

(e) All risks whatsoever connected with the work under contract until it is accepted by the engineer;

(f) All expenses incurred by or in consequence of, the suspension or discontinuance of the prosecution of the work as herein specified, and in completing the work and the whole thereof, including the carrying out of all the requirements of these "general requirements and covenants" in an acceptable manner according to the plans and specifications.

In cases where the "Basis of Payment" clause in the specifications relating to any unit price in the bid schedule, requires that the said unit price cover and be considered compensation for certain work or material essential to

the item, this same work or material shall not also be measured or paid for under any other pay item which may appear elsewhere in the specifications.

The payment of any partial estimate or of any retained percentage, except by and under the approved final estimate and voucher, in no way shall affect the obligation of the contractor to repair or renew any defective parts of the construction or to be responsible for all damages due to such defects.

9.3 Extra Work. Extra work shall be paid for in accordance with the accepted contract change order. Work specified in the order to be performed at agreed unit prices shall be paid for in the same manner as proposal items. Work specified and performed on a force account basis shall be paid for as specified in Article 9.4.

9.4 Force Account Work. Work specified and performed on a force account basis shall be paid for as follows:

(a) For all labor and the foremen in direct charge of the specific operation, the contractor shall receive the current local rate of wage, but not to exceed the rate of wage paid by him on contract items, or if the men have not been previously employed by the contractor, the rate shall be the same as for other similar labor, as evidenced by certified copies of the payrolls, for each and every hour said labor and foremen are actually engaged in such work, to which cost shall be added an amount equal to fifteen (15) percent of the sum thereof.

The wages of any foreman who is employed partly on force account work and partly on other work, shall be prorated between the two classes of work according to the number of men employed on each class of work as shown by the payrolls.

(b) For workmen's compensation insurance premiums, unemployment insurance contributions, and social security taxes on the force account work, the contractor shall receive the actual cost to which no percentage shall be added. The contractor shall furnish satisfactory evidence of the rate or rates paid for such insurance and contributions.

(c) For materials accepted by the engineer and used in the work, the contractor shall receive the actual cost of such materials, including transportation charges paid by him as evidenced by original receipted bills, to which cost shall be added an amount equal to fifteen (15) percent of the sum thereof.

(d) For any machinery or special equipment (other than small tools) including fuel and lubricants,

the use of which has been authorized by the engineer, the contractor shall receive, the rental rates which shall be the contract rate, if any, otherwise they shall be agreed upon in writing before such work is begun for the actual time that such equipment is in operation on the work, to which rental sum no percentages shall be added. By agreement with the Nevada Branch of the Associated General Contractors of America, fair rental rates for certain types of equipment have been determined. A list of these rates are appended to the special provisions. For equipment used on force account work, and for which there is no contract price, the contractor shall accept rates not to exceed those set forth.

(e) No additional allowance shall be made for general superintendents, the use of small tools or other costs for which no specific allowance is herein provided.

(f) The compensation as set forth above shall be received by the contractor as payment in full for extra work done on a force account basis, or when the proposal includes an item or items to be done by force account. At the end of each day the contractor's representative and the inspector shall compare records of the cost of the work to be done as ordered on a force account basis.

No extra work on a force account basis or force account work as called for in the proposal will be paid for unless unit prices for labor, materials, and equipment rental have been agreed upon in writing before such work is started. In no case shall the unit prices paid to the contractor exceed the amount of the quoted unit price for each item stipulated in the force account agreement.

9.5 Omitted Items. Should any items contained in the proposal be found unnecessary for the proper completion of the work contracted, the engineer may, upon written order to the contractor, eliminate such items from the contract, and such action shall in no way invalidate the contract and no allowance will be made for items so eliminated in making final payment to the contractor except for such actual work as may have been done and materials actually purchased prior to notification of the elimination of the items. In no case of this sort shall any allowance be made for anticipated profits.

9.6 Common Carrier Rate Adjustments. It is understood and agreed that the accepted proposal for the work is based on common carrier rates on file with the interstate commerce commission, or with a corresponding intrastate commission or body and in effect on the date of opening of bids. Payments to the contractor will be adjusted to compensate for increases and decreases in cost due to changes in common carrier rates becoming effective after the date of opening of proposals; and before the date stipulated for the completion of the work, including authorized extensions of time. Adjustments shall be limited to an amount determined as follows: Adjustments shall be the product of the increase or decrease of said common carrier rates multiplied

by the net quantity of material shipped at the new rates to the work, all as shown by the receipted common carrier bill.) Should there be a reduction in common carrier rates on said materials, the amount of such reduction shall be deducted by the department from any moneys due the contractor on said contract on the same basis.

9.7 Adjustment of Haul on Local Materials. In case a designated material deposit is found to contain an insufficient quantity of satisfactory material as provided in Article 6.2, the contractor shall receive the following adjustment of compensation:

(a) Costs of moving the plant from the deposit which has failed to an alternate deposit and setting up the plant at the alternate deposit shall be paid for as extra work, except that no such payment shall be made when the alternate deposit is also a deposit designated in the special provisions.

(b) Additional haul caused by a change in designated deposits shall be paid for at the rate of ten (10) cents per ton mile or fourteen (14) cents per cubic yard mile. The additional haul to be paid for shall be the product of the number of tons or cubic yards of accepted materials and the additional haul distance. The additional haul distance shall be the number of miles or fractions thereof by which the distance from the new sources, designated by the engineer, exceeds the distance the same amount of material would have been hauled had it been obtained from the nearest of the deposits designated in the special provisions. Distances shall be measured between centers of mass of the deposit source and the point of placement on the road over the shortest feasible route as determined by the engineer.

In case changes in thickness of base and surface courses result in increasing the average haul, the additional haul shall be measured, as provided below, and paid for as indicated above under paragraph (b). The additional haul distance shall be the number of miles or fractions thereof by which the average distance from the nearest designated sources to the points of actual placement on the road exceeds the average distance from the same sources to the points of placement indicated on the plans. Designated sources shall include those sources designated on the plans as well as other approved sources used by the contractor if a reduction in additional haul is accomplished by the use of such other approved sources. Additional haul to be paid for under this article shall be the net result of all changes in thickness made on the contract.

9.8 Partial Payments. Partial payments will be made once each month as the work satisfactorily progresses. The partial payments will be based upon estimates prepared by the engineer of the value of the work performed and materials complete in place in accordance with the contract. From the total of the amount ascertained, will be deducted an amount equivalent to ten (10) percent of the

whole, which ten (10) percent will be retained by the department until after completion of the entire contract in an acceptable manner; and the balance or an amount equivalent to ninety (90) percent of the whole, plus all previous payments shall be certified for payment; provided, that any time after fifty (50) percent of the work has been completed, the engineer may, if he finds that satisfactory progress is being made, make any of the remaining partial payments in full.

No such estimate or payments shall be required to be made, when, in the judgment of the engineer, the work is not proceeding in accordance with the provisions of the contract, or when in his judgment the total value of the work done since last estimate amounts to less than five hundred (500) dollars.

Should any defective work or material be discovered previous to the final acceptance or should a reasonable doubt arise previous to the final acceptance as to the integrity of any part of the completed work, the estimate and payment for such defective or questionable work will not be allowed until the defect has been remedied and causes for doubt removed.

9.9 Compensation for Altered Quantities. When alterations in plans or quantities of work not requiring supplemental agreements, as herein provided, are ordered and performed, the contractor shall accept payment in full at the contract unit prices for the actual quantities of work done, and no allowance shall be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense, on the part of the bidder and the subsequent loss of expected reimbursement therefore, or for any other cause.

Alterations of plans or of character of work involving supplemental agreements as indicated in Article 4.3 will be paid for as stipulated in such agreement.

9.10 Acceptance and Final Payment. When the final inspection and final acceptance have been duly made by the engineer, as provided in Article 5.13, and subject to the terms of Article 8.9, the engineer shall prepare the final estimate of the quantities of the various classes of work performed under the contract. The contractor shall examine such estimate and notify the engineer in writing of his agreement or file a specific claim covering disputed items. Failure on the part of the contractor to so notify the engineer or file a claim within a period of thirty (30) days after receipt of the estimate shall be construed to signify the contractor's agreement to the quantities as set forth, and he shall have no further claim against the department, except as indicated in the final estimate of quantities. Final payment shall be due and payable at the expiration of not less than thirty (30) calendar days nor more than sixty (60) calendar days from the date of final acceptance.

Final acceptance of the work by the engineer shall be withheld until the contractor furnishes all certificates, guarantees, releases, affidavits, etc. required by these specifications or the special provisions.

SECTION 10 - WAGES AND CONDITIONS OF EMPLOYMENT

10.1 Description: The provisions pertaining to wages and conditions of employment shall apply to all work performed (on the contract) by the contractor with his own organization and with the assistance of workmen under his immediate superintendance, and to all work performed on the contract by subcontract.

10.2 Laws Cited. The contractor's attention is directed particularly to the provisions and requirements of the following:

(a) Wages, Hours and Employment on Public Works -- Nevada Revised Statutes, Chapter 338.

(b) Nevada Industrial Insurance Act. -- Nevada Revised Statutes, Chapter 616. (The contractor will be required to furnish a certificate from the Nevada Industrial Commission as evidence that he has paid all the premiums and percentages as required by the act, and said certificate shall be furnished the engineer before any work is commenced.)

(c) Unemployment Compensation Law -- Nevada Revised Statutes, Chapter 612.

(d) Highway Camp Sanitation -- Nevada Revised Statutes, Secs. 444.130-444.200 and 444.210.

And any and all legislation, rules or regulations promulgated by the State of Nevada, or its agencies, covering any work performed by the contractor.

PART II
CONSTRUCTION DETAILS

SECTION		PAGE
11	ACCOMODATIONS FOR PUBLIC TRAFFIC.	56
12	CLEARING AND GRUBBING	63
13	REMOVING EXISTING CULVERTS BRIDGES AND RETAINING WALLS	66
14	REMOVING MISCELLANEOUS STRUCTURES	69
15	ROADWAY AND DRAINAGE EXCAVATION	73
16	BORROW.	79
17	SELECTED BORROW	81
18	ROUNDED AND TRANSITION SLOPES	83
19	OVERHAUL.	84
20	EMBANKMENTS	85
21	STRUCTURE EXCAVATION.	91
22	BACKFILL.	95
23	FOUNDATION FILL	98
24	(BLANK)	
25	(BLANK)	
26	RESHAPING ROADWAY	99
27	ROADSIDE CLEANUP.	100
28	WATERING	101
29	ROLLING	103
30	GRAVEL BASE COURSE.	107
31	(BLANK)	

SECTION		PAGE
32	SELECTED MATERIAL SURFACE COURSE	110
33	APPLICATION OF BITUMINOUS BINDING	112
34	PRIME COAT	121
35	SEAL COAT	123
36	SURFACE TREATMENT	125
37	ARMOR COAT	128
38	ROADMIX SURFACE	131
39	RETREAD SUFACE	139
40	PLANTMIX SURFACE	143
41	(BLANK)	
42	(BLANK)	
43	(BLANK)	
44	PORTLAND CEMENT CONCRETE	156
45	CONCRETE STRUCTURES	169
46	WATERPROOFING AND DAMPPROOFING	185
47	REINFORCING STEEL	187
48	STEEL STRUCTURES	190
49	TIMBER STRUCTURES	206
50	PILING	212
51	PAINTING	221
52	PRESERVATIVE TREATMENTS FOR TIMBER	231
53	(BLANK)	
54	CORRUGATED METAL PIPE CULVERTS	233
55	REINFORCED CONCRETE PIPE CULVERTS	237
56	NON-REINFORCED CONCRETE PIPE	242
57	STRUCTURAL PLATE CULVERTS	244
58	RELAYING CULVERT PIPE	246

SECTION		PAGE
59	MOVING PIPE CULVERT HEADWALLS	247
60	UNDERDRAINS	248
61	METAL EMBANKMENT PROTECTORS	250
62	CATCH BASINS, INLETS AND MANHOLES	252
63	(BLANK)	
64	RIPRAP	254
65	RUBBLE MASONRY	257
66	BITUMINOUS TREATED FOOTPATHS	260
67	CONCRETE CURBS, GUTTERS AND SIDEWALKS	262
68	CONCRETE SLOPE PAVEMENT	266
69	(BLANK)	
70	FENCING	268
71	GUARD RAIL	272
72	CULVERT MARKERS AND GUIDE POSTS	275
73	(BLANK)	
74	RIGHT OF WAY MARKERS	279
75	MONUMENTS	280
76	RIASED TRAFFIC BARS	281
77	SIGNALS AND LIGHTING	283
78	(BLANK)	
79	FIELD LABORATORY	317

PART II · CONSTRUCTION DETAILS

PART II

CONSTRUCTION DETAILS

SECTION 11 - ACCOMMODATIONS FOR PUBLIC TRAFFIC

11.1 Description. This item shall consist of providing accommodations for public traffic by detouring traffic over existing roads, by permitting traffic to pass through construction operations, by constructing and maintaining special detours, or by a combination of these methods as indicated on the plans or in the special provisions or as directed in writing by the engineer.

11.2 Materials. The materials used for the construction and maintenance of facilities required for the free flow of public traffic and for protection of the work shall be those prescribed for the several items which constitute the finished work and shall conform to all the requirements for such materials as set out in Part III, Material Details or as otherwise specified.

11.3 General Requirements. Methods of handling traffic, if required, will be shown on the plans or in the special provisions.

No road or section thereof shall be closed to traffic unless provided on the plans, in the special provisions, or permitted by the engineer.

The contractor shall conduct his operations and the use of his equipment in such a manner that two-way traffic will continuously be provided throughout the entire length of the project, including special detours where required.

When conditions are such as to warrant variations from the requirement that two-way traffic be maintained, the exact procedure to be followed shall be approved by the engineer before traffic conditions are changed.

Access shall be permitted to residences, buildings, and driveways adjacent to existing roads, the road under construction, or special detours at all times and the contractor shall provide such temporary approach roads as may be required for this purpose.

When it is necessary for residents living along the project to use a portion of the road under construction, the contractor shall maintain, within the limits of these specifications, that portion of the road in a suitable condition for such vehicular traffic.

The engineer may authorise a suspension of work when unfavorable weather or other conditions not the fault of the contractor make such a suspension advisable. During such a suspension the contractor shall make passable and shall open to traffic such portions of the highway under improvement and such temporary roadways or portions thereof as may be agreed upon between the contractor and the engineer for the temporary accommodation of necessary traffic during the anticipated period of suspension. Thereafter, and until an issuance of an order for the resumption of construction operations, the maintenance of the temporary route or line of travel agreed upon shall be by and at the expense of the state. When work is resumed the contractor shall replace or renew any work or materials lost or damaged because of such temporary use of the highway under improvement; shall remove any work or materials used in the temporary maintenance thereof by the state; and shall complete the improvement in every respect as though its pros-

ecution had been continuous and without interferences. All additional work caused by such suspension shall be paid for by the state at agreed prices or by force account when agreement cannot be reached.

During non-working hours the limits of any hazardous section shall be outlined with markers and flares placed not more than one hundred (100) feet apart. If deemed necessary by the engineer, barricades shall be erected to protect public traffic from such hazardous areas or he may direct the contractor to furnish flagging and piloting, if in his opinion conditions so warrant. Such flagging and piloting shall be done at the contractor's expense, provided, however, that flagging and piloting by the contractor after regular working hours will not be required if the contractor each day will leave the work in such a condition that it can be traveled over without damage to the work and without danger to the traffic. The engineer shall be the judge as to whether or not these conditions are satisfactorily complied with, and as to whether or not flagging and piloting can be dispensed with after working hours.

When the contractor's hauling equipment is required to merge with or cross traffic, and at such other points as may be necessary to maintain safe traffic condition flagmen shall be provided on each side of the impairment to stop and direct traffic.

All flagmen furnished for the protection of the public and direction of traffic shall perform their duties in a courteous manner with a view to insuring the safety and convenience of the traveling public within the limits of the guarded area. The contractor shall immediately correct any deficiency in equipment or flagging procedure brought to his attention by the engineer.

Each flagman shall be supplied, for use in daylight, with a red shirt or jacket, red cap and with a red flag not less than 18 inches by 18 inches square mounted on a staff. To stop traffic in daylight, the flagman shall stand at the edge of the traffic lane, facing approaching traffic, with his arm and hand extended into the traffic lane, holding the red flag across the traffic lane. The red flag shall be held without waving so that the full area of the flag is below the staff and visible to the approaching traffic. In daylight, traffic shall be signaled to proceed by lowering the red flag and waving the arm (not the flag) in a forward direction.

Between the hours of sunset and sunrise the flagman shall be supplied with a white shirt or jacket and cap, and shall be equipped with lighted red lanterns or red light torches, and for emergencies, red light fuses. To stop of slow down traffic the red lantern or torch shall be waved back and forth across the field of vision of the drivers of approaching traffic. To signal traffic to proceed, a hand signal or verbal order shall be given.

Whenever it is necessary to divert the flow of traffic from its normal channel into another channel, the channel for such diverted traffic shall be clearly delineated by temporary markers or small temporary barricades. On tangents the temporary markers or small temporary barricades shall be placed not farther apart than two hundred (200) feet. On curves, the spacing of the temporary markers shall not be greater than the following:

> Six thousand (6000) foot radius to two thousand (2000) foot radius, two hundred (200) feet; under two thousand (2000) foot radius to nine hundred fifty (950) foot radius, one hundred (100) feet; under nine hundred fifty (950) foot radius to four hundred (400) foot radius, forty (40) feet; under four hundred (400) foot radius, twenty (20) feet.

In case of damage to detours due to storms or other causes, the contractor shall at once repair the damage or provide for carrying traffic through construction

operations.

None of the provisions herein shall be construed to restrict or prohibit, at any time, the prosecution of items of work which will not interfere with the use of the existing highway.

11.4 Carrying Traffic Through Construction Operations. Where public traffic is carried through construction, it will be necessary to permit traffic to use a portion of the roadway during progress of the work. Roadway excavation and embankment constructions shall be conducted in such a manner as to provide a reasonably smooth and even surface satisfactory for use of public traffic at all times. If ordered by the engineer, roadway cuts shall be excavated in lifts and embankments constructed part width at a time, construction being alternated from one side to the other side and traffic routed over the side opposite the one under construction. Culverts shall be installed and backfilled one-half width at a time, or at each structure the contractor may construct and maintain, at his own expense, short run-around detours acceptable to the engineer.

Every attempt shall be made to provide adequate width for two lanes of traffic; these traffic lanes shall be kept smooth, free from ruts, holes, rocks, ridges and bumps, by use of equipment, labor, and materials as may be necessary to accomplish this purpose. If, in the opinion of the engineer, the usable roadway is not sufficient to safely accommodate two-way traffic, the contractor shall adequatly maintain one-way traffic. Whenever one-way traffic is in effect, the distance shall not be in excess of six thousand (6000) feet.

Where controlled traffic is necessary for protection of the work or for safety of public traffic, it shall be handled in the following manner:

(a) Flagman will be required and used at all hazardous areas during grading operations.

(b) If, in the opinion of the engineer, it is necessary to afford additional protection to the work, workmen, or public traffic through construction operations, a pilot car and driver shall be used as he so directs.

(c) Flagman and pilot car and driver will be required as directed by the engineer, when it is indicated on the plans, or provided in these specifications or the special provisions during paving operations and surface treatment.

Pilot cars shall be suitable vehicles in good mechanical condition and shall carry a sign which shall comply with the design and mounting as shown in the standard drawing appended to the special provisions.

Water shall be applied at points and in amounts directed by the engineer to keep the roadbed firm, smooth, and stable, and reduce the dust hazard to a minimum.

Whenever blasting is necessary, which will interfere with, endanger, or delay traffic, the operations shall be so conducted that traffic will not be delayed for periods longer than twenty (20) minutes. Such blasting shall be done only during hours when the volume of traffic is at a minimum.

The contractor shall maintain all structures or portions of structures in a condition for safe and convenient use. The contractor shall also maintain adequate guard rails, temporary markers, lights, signs, and such other traffic control devices, and flagmen as may be necessary to maintain safe traffic condi-

tions.

The contractor shall maintain the subgrade, unprimed or primed base courses over which traffic is directed. This maintenance shall constitute continuous and effective work prosecuted day by day with adequate equipment and forces to the end that the subgrade or base is kept free from ruts, ridges, holes, and in satisfactory condition at all times.

11.5 Passing Traffic Over Existing Roads. Where traffic is diverted over existing roads, approach roads from the new grade to the old road shall be provided to properly accommodate traffic. Such approach roads shall be constructed to a width comparable to the existing road and shall be constructed in a manner satisfactory to the engineer before beginning work on the corresponding section of the new highway.

The existing road shall be widened and realigned as may be necessary to avoid conflict with the proposed new construction.

The contractor shall be responsible for maintenance of the existing roads used by public traffic during construction and until the project is finally accepted, except for authorized suspensions of the work due to seasonal weather conditions during the winter months, when such maintenance shall be by and at the expense of the state. The maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment, and forces to the end that the roadway and structures are kept in satisfactory condition at all times, provided however, that snow removal will not be required of the contractor for the accommodation of public traffic.

All cost for this maintenance work during construction and before the work is finally accepted shall be included in the unit prices bid on the various pay items and the contractor will not be paid an additional amount for such work.

Failure on the part of the contractor, at any time, to comply with the provisions above will result in the engineer immediately notifying the contractor, in writing, to comply with the required maintenance provisions. In event that the contractor fails to remedy unsatisfactory maintenance within the time allowed by the engineer, in his written notice, the engineer will immediately proceed with adequate forces and equipment to maintain the project, and the entire cost of this maintenance will be deducted from moneys due or which may become due the contractor under this contract.

When windrowed material is left on the roadbed at night, such windrows shall be moved as far to one side of the roadbed as feasible, and the windrows shall be outlined with flares and reflectorized guide markers placed not more than one hundred (100) feet apart. The windrow shall be flattened at points where traffic has to cross.

11.6 Special Detours. Special detours shall be constructed as shown on the plans or as specified in the special provisions. Detour locations indicated on the plans are approximate only; the exact location shall be as staked by the engineer.

Grading for special detours shall consist largely of blade grader work, supplemented where necessary by other mechanical equipment, to provide the specified roadbed width and a grade line free from breaks or rolls of sufficient magnitude to be hazardous to traffic.

When grading of special detours has been completed and approved by the

engineer and, if required on the plans or in the special provisions, the special detours shall receive surfacing materials of the kind and type specified, and they shall be placed and constructed in accordance with the requirements for the particular materials used.

Water shall be applied to detours in amounts and at points as directed by the engineer to assist in the compaction of graded sections and of surfacing materials.

Maintenance on special detours shall consist largely of filling holes as they develop, adding surfacing, and applying liquid asphalt, blading, watering, and performing any other work necessary to maintain the detour satisfactorily, all as ordered by the engineer.

Upon disturbing the existing roadbed corresponding to a special detour, grading operations shall be prosecuted continuously to completion. Placing of the mineral aggregate courses shall immediately follow completion of grading operations; and, in the case of gravel base course, bituminous prime coat shall be applied as soon thereafter as sections of sufficient length are available to permit traffic to travel over the primed or unprimed base course until such time as the remaining surfacing materials are being placed, at which time, traffic shall again be diverted over the special detours. Maintenance of unprimed or primed base shall be as set forth in Article 11.4. If traffic is diverted over the unprimed base, water shall be applied at such points and in such amounts as to keep the roadbed firm, smooth, and stable, and reduce the dust hazard to a minimum.

After traffic has been turned over the completed new roadbed, temporary detour approach roads and those portions of special detours which are visible and unsightly from the new highway shall be removed and obliterated as directed by the engineer.

11.7 Barricades and Warning Signs. The contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient flares or red lights, danger signals and standard warning signs at locations shown on the plans, as set forth in the special provisions, or as directed by the engineer, for the protection of the work, workmen, and guidance and safety of the traveling public. Highways closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. The contractor shall provide and maintain acceptable warning and detour signs at all closures, intersections, and along the detour routes, directing the traffic around the closed portions of the highway so that the temporary detour route or routes shall be indicated clearly throughout its or their entire length. All barricades, signs, and obstructions shall be illuminated at nights, and all lights for this purpose shall be kept burning from sunset to sunrise.

All standard warning signs and barricades shall conform with standard details and "Construction Sign Requirements" appended to the special provisions, and shall be substantially constructed of wood or enameled metal. Wooden signs and barricades shall be painted with a prime, second and third coat of paint in accordance with Section 51. The final coat shall present a smooth semi-gloss finish.

Lettering and design shall be true to detail as shown on the standard details with sharp clear-cut lines and a glossy finish.

Except as set forth below coatings of wide-angle reflecting material applied to the entire background area of the signs shall be used when reflectorized signs are called for. These coatings shall be of the same color as indicated for such signs on the standard sign sheets and shall be retro-directive reflecting in character. Before application of the reflective coating, the background shall have been painted as specified above.

Signs indicated with a black background, shall have a black painted background, and the letters, symbols, or numerals shall be white, wide-angle reflecting coatings on the black painted background. The character of these reflective coatings shall be approved by the engineer.

Signs and barricades shall be maintained in first-class condition and any which may become scarred or damaged shall be repaired immediately or replaced as directed by the engineer.

After completion of any portion of the work rendering continued use of the signs or barricades unnecessary, the contractor shall at once, remove, move, or change them, as directed by the engineer.

All signs and barricades (except state furnished signs) shall be the property of the contractor and shall be disposed of by him upon completion of the contract.

In addition to the signs and barricades required above, or in the special provisions, the contractor shall furnish and erect, at his own expense, such other signs and safeguards as may be necessary to protect the public traffic, workmen, and the work on account of his operations.

Upon failure of the contractor to immediately provide, erect, and maintain or to move or remove such barricades and the standard signs when ordered so to do by the engineer, the engineer shall be at liberty without further notice to the contractor or to the surety to provide, erect and maintain or to move or remove barricades and lights and to provide, erect and maintain or to move or remove standard signs and deduct the cost thereof from any money due or which may become due the contractor.

The responsibility for the protection of the work, workmen, and public traffic will rest with the contractor and he shall be liable for damages and injury suffered by reason of the contractor's operations or any circumstances, conditions, actions, or negligence in connection therewith.

11.8 Alternate Methods. If the contractor desires to handle the work or traffic in a manner different from that outlined above, he shall submit in writing an outline of the plans he proposes. If, in the opinion of the engineer, such plan will provide for handling traffic in a satisfactory manner and at a cost which will not exceed the cost of providing for traffic as outlined above, permission may be granted to substitute the contractor's plan for the method set forth herein or in the special provisions. Any changes made under these provisions shall be covered in writing on the department contract change order forms.

11.9 Method of Measurement and Basis of Payment. Reimbursement for all costs of carrying traffic through construction operations shall be measured and paid for as follows:

When the proposal contains an item of "Flagman" the flagging as specified herein, in the special provisions, or ordered by the engineer, shall be measured by the number of hours that flagmen are actually used to direct traffic through construction operations, to stop traffic preparatory to piloting operations, and at each point where contractor's equipment enters or interferes with the traffic stream, and shall be paid for at the contract unit price bid per hour for "Flagman", which price shall be full compensation for all equipment, competent personnel and all incidentals necessary for the operation.

When the proposal contains the item of "Pilot Car", the piloting as specified herein, in the special provisions, or as ordered by the engineer, shall be measured by the number of hours that the pilot car and driver are actually used to lead traffic through the controlled areas, and shall be paid for at the contract unit price bid per hour for "Pilot Car", which price shall be full compen-

sation for the vehicle and an experienced driver, all operating costs and depreciation.

If the proposal includes an item of "Maintain Base" it shall be paid for on a force account basis in accordance with Articles 4.5 and 9.5 of these specifications.

If the roadway excavation encountered in the construction of special detours or in the construction and removal of approaches to an existing highway, from the new to the old grade, is deemed sufficient to require mention on the plans or in the special provisions, such excavation shall be measured and paid for as specified under Section 15.

If the proposal contains an item for "Selected Detour Surfacing" in lieu of other materials covered in the standard specifications, selected detour surfacing shall be measured in tons or cubic yards, in the hauling vehicles at the point of loading, as indicated by the unit stated in the proposal form. "Selected Detour Surfacing" measured as provided above, shall be paid for at the contract unit price bid per ton or cubic yard, as the case may be, which payment shall be full compensation for stripping of pit, crushing, screening, loading, hauling, placing materials on roadbed and compacting complete in place.

Liquid asphalt, if required to prepare a surface for special detours or for laying of dust, shall be measured as specified in Section 33 and paid for at the contract unit price for the particular type of material required.

All other work necessary for the construction and maintenance of special detours, shall be paid for on a force account basis in accordance with Articles 4.5 and 9.5, except that equipment for which there is a contract price shall be paid for at the contract unit price bid per hour for the particular item of equipment required. The estimated amount of equipment and number of hours of operation shall be as indicated in the proposal form.

The particular items of equipment indicated in the proposal form, or the equivalent thereof, in good mechanical operating condition shall be paid for at the contract unit price per hour for the particular item of equipment required. The contract unit price bid per hour for equipment shall include skilled operators for each piece of equipment, fuel, lubricants, repairs, depreciation, and all expense incidental to the operation of the equipment. The time allowed for such equipment shall be the actual time the equipment is in operation on the work.

Unless otherwise provided in the special provisions or the proposal includes a contract item, the costs of necessary watchmen, or flagmen, and of furnishing, erecting, maintaining, moving, removing, and replacing any signs or barricades, torches and lights, temporary markers or other devices, and furnishing flagging materials which are required herein, shown on the plans or otherwise ordered, or which may further be necessary for the protection of the traveling public, the work, or the contractor's workmen, will not be paid for directly, but the cost thereof shall be included in the various pay items of the contract.

The contract lump sum price for "Signs" shall be full compensation for furnishing, erecting, maintaining, moving, removing, and disposing of the signs and barricades and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

When roadmixed detours are called for on the plans or in the special provisions, roadmixing shall be done in accordance with Section 38.

SECTION 12 - CLEARING AND GRUBBING

12.1 Description. This item shall consist of cutting and disposing of all trees, brush, shrubs, windfalls, logs and other vegetation and objectionable matter, together with the removing from the ground and disposing of all stumps, roots, and debris from within the limits hereinafter defined.

12.2 Areas to be Cleared. Areas to be cleared shall be as follows:

(a) The entire area upon which highway construction is to be performed to a width of one (1) foot outside excavation and embankment slope lines, except where slopes are to be rounded, and in which case the area shall extend to the outside limits of slope rounding, as detailed on standard drawing "Standard Slope Rounding and Warping".

(b) F.B. ditch and dike areas to a width of one (1) foot outside the slope lines.

(c) Areas on which service highways or streets, ramps, approaches and all other accessory roads and connections are to be constructed, such areas to extend to a width of one (1) foot outside excavation and embankment slope lines.

(d) Material sites and borrow pits [illegible].

12.3 Construction Methods. Before starting excavation and grading, the natural ground surface within the limits set forth above shall be cleared of all vegetation, such as trees, brush, shrubs, heavy growth grass and weeds, logs, windfalls, upturned stumps and all other objectionable material.

Within the limits set forth above, the areas below the natural ground surface shall be grubbed of all stumps, large roots, buried logs and all other objectionable material, except where cuts will be three (3) feet or more in depth, the grubbing may be done simultaneously with the excavation, provided satisfactory precautions are taken to insure that all vegetable growth and other objectionable material are removed as the excavation proceeds and that no such objectionable material shall be left in or under embankments or dikes.

All trees, shrubs, brush, existing stumps and large roots within areas where fills will be three (3) feet or more in height shall be cut flush with the existing ground and grubbing of the remaining vegetable growth will not be required, except at locations where a structure is to be constructed or unsuitable material is to be removed.

Trees and shrubbery located beyond clearing limits shall not be removed unless their removal is specifically authorized. Such trees and shrubs to be left in place on the right-of-way or those outside the right-of-way limits shall not be damaged or injured by the contractor, and the contractor shall be held responsible for any unnecessary damage thereto resulting from construction operations.

Where feasible, trees shall be felled towards the center to the area to be cleared. Where trees cannot be felled without danger to traffic or injury to other trees, structures or property, they shall be cut in sections from the top down.

When limbs or branches of trees to be left in place overhang the roadbed and do not leave a clearance of at least twenty (20) feet above the finished grade, such trees shall be carefully and symmetrically trimmed of their lower limbs or branches so as to provide a clearance of not less than twenty (20) feet above the roadbed. Such trimming shall be performed in a manner as directed and in accordance with generally accepted horticultural practices and all cut surfaces one (1) inch or more in diameter shall be painted with a heavy coat of an approved tree paint.

All timber from which saw logs, pulp wood, posts, poles, ties, or cord wood can be produced shall be considered as merchantable timber and shall be cleaned of limbs and tops and sawed into merchantable length. The contractor will not be required to cut merchantable timber into less than twelve (12) foot lengths.

All merchantable timber shall, unless otherwise specified, remain the property of the state and shall be neatly piled along the right-of-way as directed.

All stumps, roots, brush, waste logs, and limbs, timber tops and other debris, resulting from clearing and grubbing or occuring within the clearing and grubbing limits, shall be piled and burned within the clearing limits at such times and in such manner as not to injure trees or shrubs which are to be left in place and so as not to cause damage to public or private property and in full accordance with Article 7.18, provided, however, that any such material not disposed of by burning, shall be disposed of out of sight from the highway, and written permits for such disposal shall be obtained by the contractor from the owner of the property upon which the material is placed and such permits or copies thereof shall be filed with the engineer.

Burning of rubbish and clearing debris shall be performed prior to proceeding with grading operations, however, in the event burning permits cannot be secured from the proper authorities at the time contemplated for disposal of such debris, or burning is impossible on account of climatic conditions, the refuse shall be piled at the sides of the right-of-way or other areas designated by the engineer outside of roadway slopes where it can be burned without danger of the fire spreading to adjoining areas, and it shall then be burned as soon as the restrictions are removed. In such event the work under the item of clearing shall be construed to include piling or clearing debris beyond the limits affected by the work until such time as burning permits can be secured. Rehandling and disposal of such materials shall not delay the other work.

12.4 Method of Measurement. Clearing and grubbing will be measured by the acre or on the lump sum basis. The quantity to be measured, when the acre basis is used, shall be the area computed on the basis of units of one hundred (100) feet in length multiplied by the average width of each unit within the lines so designated. Any such unit on which there is no clearing and grubbing shall not be measured for payment.

Unless specifically provided for in the special provisions, none of the work of clearing and grubbing material sites or borrow sites will be paid for.

when such material sites or borrow sites are outside the right-of-way.

When so provided in the proposal, individual trees six (6) inches or more in diameter measured at a point approximately three (3) feet above existing ground level, or stumps shall be measured for payment as units.

12.5 Basis of Payment. Clearing and grubbing, measured as provided above, shall be paid for at the contract unit price bid per acre or lump sum price for "Clearing" which payment shall be full compensation for all clearing and grubbing actually required and performed within the clearing limits on those portions of the work where clearing is designated on the plans or authorized, and for furnishing all labor, materials, tools, supplies, equipment and performing all the work involved as herein specified, including the handling, piling, burning, rehandling, and disposal of resulting debris.

When the proposal contains separate items for removal of trees or stumps and measured as provided above, trees or stumps ordered removed, shall be paid for at the contract unit price bid each for "Remove Trees", "Remove Stumps" or "Remove Trees (_____ inch to _____ inch",) as the case may be, which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

The item of "Remove Trees" or "Remove Stumps" shall not apply on any section when the item of "Clearing" appears in the proposal.

When the proposal does not include an item for clearing and grubbing as above specified, and unless otherwise provided in the special provisions, full compensation for any necessary clearing and grubbing required to perform the construction operation specified shall be considered as included in the price paid for other items of work and no additional compensation will be allowed therefor.

SECTION 13 - REMOVING EXISTING CULVERTS, BRIDGES, AND RETAINING WALLS

13.1 Description. This item shall consist of the removal in whole or in part, of all existing bridges, culverts, siphons, and retaining walls as shown on the plans, or required in the special provisions, or ordered by the engineer. It shall also include the salvage, storage, and disposal of all materials, refill of all resulting trenches and the compaction of the materials in trenches within the roadway area.

13.2 Construction Methods. (a) Breaking Down and Removal. Existing culverts, bridges, siphons, and retaining walls which are within the highway and interfere with new construction, or are rendered useless by new construction shall be removed unless otherwise provided on the plans or in the special provisions.

Existing culverts and bridges which are beyond the limits of the highway shall remain in place and in service unless otherwise noted on the plans, or in the special provisions, ordered by the engineer.

If any part of the structure or the structure in its entirety is to be salvaged, it shall be removed in such a manner as not to damage the material. Equipment, or methods which might damage the members, portions of the structure to be preserved, or adjacent construction shall not be used. Explosives shall not be used except upon written permission of the engineer.

Where existing culverts and bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as is necessary to provide a proper connection to the new work. The connecting edges shall be cut, shaped,, and trimmed to the required lines and grades without weakening or damaging the part of the structure to be retained. Reinforcing bars which are to be left in place so as to project into new work as dowels or ties, shall not be injured during removal of concrete.

Pipe culverts shall be carefully removed in such a manner as to avoid damage thereto.

Steel structures, shall, unless otherwise provided, be carefully dismantled in such a manner as to avoid damage to reusable members. If the special provisions specify that the structure is to be removed in a condition suitable for re-erection, all members shall be match-marked by the contractor with white lead paint before dismantling. All pins, nuts, loose plates, and so forth shall be similarly marked to indicate their proper location. All pins, pin holes and machined surfaces shall be painted with a mixture of white lead and tallow or other approved rust preventative, and all loose parts shall be securely wired to adjacent members or packed in boxes.

Materials salvaged from existing structures may, subject to approval of the engineer, be used temporarily in the construction of the new work. However, the temporary use of match-marked material must be specifically authorized in the special provisions.

Timber structures shall be removed in such a manner as to avoid damage to the timber or lumber designated by the engineer, as salvable material. Except for cribs and similar timber structures which will be within the limits of new

embankments, all existing piles, cribs, or other timber structures shall be removed to an elevation of at least two (2) feet below the finished ground line. However, if the existing ground line is more than two (2) feet below the finished grade line, all such construction shall be removed to the existing ground line. All existing cribs, and similar timber construction which will be within the limits of new embankments, shall be removed entirely.

When the diameter or span of a culvert is less than four (4) feet, and the top thereof is five (5) feet below finished roadway grade, and unless otherwise noted on the plans or ordered by the engineer, the culvert need not be removed but shall be abandoned and closed as hereinafter described. The headwalls of such culverts, or any part of the structure that is within two (2) feet of the finished grade line shall be removed. The ends of the culvert shall be completely filled with satisfactory soil for a distance of at least two (2) feet, plus the height of the opening of the structure.

(b) Disposing of Materials. All materials having salvage value, shall be placed in neat piles outside the roadway and within the right-of-way, at points designated by the engineer. Suitable salvage material may be used in the construction of the new work when so provided in the special provisions or ordered by the engineer.

Unless otherwise provided, excavated material shall be used in backfilling excavations made in removing the structure, in constructing embankment or otherwise disposed of as directed.

When the construction of riprap and similar structures is included in the proposal, suitable broken concrete or masonry removed from old structures may be used in such construction. Any concrete or masonry which cannot be placed in backfills or embankments or used as riprap, shall be disposed of as directed and in such a manner as to prevent damage to property or the creation of unsightly conditions. The material shall not be placed where it will obstruct the natural flow of the stream.

When concrete or masonry is placed in embankments, it shall be placed in parallel layers so that the voids therein are filled with satisfactory and thoroughly compacted soil, but no such material shall be placed closer than six (6) inches to the subgrade.

Pipe culverts that are removed and deemed salvable by the engineer, shall be cleaned and neatly piled on the right-of-way at points designated by the engineer.

Structural steel removed from old structures shall, unless otherwise specified or directed, be stored in a neat and presentable manner on blocking and at locations suitable for loading. Structures or portions thereof which are specified in the special provisions for re-erection shall be stored in separate piles.

Timber or piling from all structures which is designated by the engineer as material to be salvaged shall have all nails and bolts removed therefrom and shall be stored in neat piles at locations suitable for loading.

Timber, lumber and old culverts which are not to be salvaged, shall be burned or otherwise disposed of as directed and in such a manner as to prevent damage to property or the creation of unsightly conditions.

(c) Backfilling. All trenches resulting from the removal or breaking down of old culverts, retaining walls, bridges, etc., and not occupied by new structures or required for waterways, shall be filled with satisfactory stone, broken masonry and satisfactory soil, and which shall be placed in layers not more than twelve (12) inches in thickness, each layer thoroughly compacted.

13.3 Method of Measurement. Removal of bridges, or portions thereof, reinforced box or concrete arch culverts, corrugated metal or concrete siphons, and retaining walls will be measured as units complete for each specific bridge, culvert, siphon, or retaining wall, for the removal of which a unit bid price is called for in the proposal.

Removing corrugated metal pipe, concrete pipe or vitrified clay pipe will be measured in linear feet of pipe actually removed in the work.

13.4 Basis of Payment. The accepted quantities of this item will be paid for at the contract unit price bid each for "Remove Bridge", "Remove Reinforced Concrete Box Culvert", "Remove _____ Siphon", or "Remove Retaining Wall", which payment shall be full compensation for all materials, labor, tools, supplies, equipment, and incidentals necessary to complete the work.

When the proposal contains a lump sum price for the removal of any of the above described structures, such lump sum price shall be full compensation for the removal and disposal of the existing structures, which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

When the proposal includes an item for removing specific corrugated metal pipe, concrete pipe or vitrified pipe culverts, the contract unit price bid per linear foot for "Remove Culvert Pipe" shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

The removal and disposal of all other culverts, required to be removed will be considered as incidental to the construction of new culverts or other new structures, provided that where the culvert is not to be replaced, the work of removing will be considered included in the contract price for roadway excavation.

The material required to refill the space occupied by removed structures or culverts, in excess of that excavated during their removal, will be obtained from roadway excavation or from borrow if such an item appears in the proposal.

Refilled units will not be paid for directly, the cost thereof shall be included in the various pay

SECTION 14 - REMOVING MISCELLANEOUS STRUCTURES

14.1 Description. This item shall consist of removing existing roadway surface and base courses, curb or curb and gutter, sidewalks, masonry, fence, poles, manholes, catch basins, headwalls, and inlets or other encumbrances which are in place but are not suitable to remain in the roadway or are otherwise considered objectionable, salvaging and disposing of the resulting material, and backfilling the resulting trenches and pits, all as indicated on the plans or directed by the engineer, and shall also include the removal and satisfactory disposal of all buildings so indicated.

14.2 Construction Methods. (a) Breaking Down and Removing. All existing structures with all attached parts and connections that are shown on the plans to be removed or that interfere with new construction shall be entirely removed within the limits shown unless otherwise provided.

Portland cement concrete, asphaltic concrete and other similar pavements not suitable for re-use shall be broken up and disposed of by incorporating in embankments, or placing as directed by the engineer at points where the material will not impair the appearance of the roadside.

In removing P.C. or A.C. pavement, curb, curb and gutter, sidewalk, and similar structures, where portions of the existing structures are to be left in the surface of the finished work, the structure shall be removed to an existing joint, or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections in the new work.

Gravel, roadmix, or plantmix surface suitable for re-use shall be removed to the depth required, and surfacing so removed shall be carefully salvaged and placed in compact stockpiles at locations designated by the engineer. Care shall be exercised to prevent admixture of earth or other foreign materials, and sites of stockpiles shall be leveled to avoid undue loss of material. These surfaces, where not deemed by the engineer to be suitable for re-use, shall be scarified and incorporated in embankments as set forth in Section 20, Embankments".

Buildings shall be moved to new locations or demolished as indicated on the plans or ordered by the engineer. Buildings moved to new locations shall be placed on carefully graded sites and set upon foundations similar to the foundations on which the buildings originally sat. The contractor shall use precautions to prevent buildings from being damaged, but if damage is done, he shall repair them at his own expense. All power lines, water lines, sewers, and other appurtenances to the building shall also be moved and reconnected. When moved, buildings shall be in as good or better condition than before moving.

All masonry walls, piers, foundations and similar structures shall be removed entirely or broken down within the areas of the roadbed to an elevation at least two (2) feet below subgrade.

Timber structures shall be removed as prescribed in Article 13.2.

Unused materials from removed buildings and foundations shall be carefully removed and materials of salvable value shall be neatly stored on the abutting property if the owner desires them. If not, disposal shall be as directed.

Fences and gates to be re-used, shall be removed in such a manner that so far as practicable all material can be salvaged. Wire fence shall be carefully removed from the posts and rolled in rolls of such size that can be conveniently handled. Posts shall be removed by methods that will keep breakage to a minimum. Unless

otherwise directed, the removed fence shall be carefully stored at points designated on the right-of-way.

In removing manholes, catch basins, and inlets, any live sewers connected to them shall be rebuilt and properly reconnected and a satisfactory by-pass service will be maintained during such construction operations.

If the plans call for abandoning manholes, catch basins, and inlets, they shall be thoroughly cleaned and existing pipe connections shall be plugged with concrete of the class and grade specified for structures. The walls of the structures shall then be removed to the required elevation.

When a portion of the existing structure is to be retained, care shall be taken during construction operations so as not to impair the value of the retained portion.

Pipe culvert headwalls shall be demolished in such a manner that the ends of the pipe are not injured.

Removal of public utilities will ordinarily be performed by the company owning the property.

All operations necessary for the removal of any existing structure which might endanger the new construction shall be completed prior to the construction of the new work.

No equipment or devices shall be used which might damage structures, facilities or property which are to be preserved and retained.

Existing structures, such as drainage pipe and minor irrigation structures or parts of such structures, shall be removed as noted on the plans and directed by the engineer.

(b) Disposing of Materials. All materials having salvage value shall be carefully removed to avoid damage and shall be placed in neat piles outside the construction limits within the right-of-way. Salvaged material may be used in new construction as provided in the special provisions, as indicated on the plans, or as directed by the engineer. All concrete, stone, brick and other material having no salvage value will be disposed of as set forth in Section 13, "Removing Existing Culverts, Bridges and Retaining Walls".

(c) Backfilling. All trenches, holes and pits, resulting from the breaking down and removal of miscellaneous structures, shall be filled with satisfactory soil or with broken masonry and satisfactory soil, placed in layers not more than twelve (12) inches in thickness. Each layer shall be thoroughly compacted by tamping or flooding or both as directed by the engineer.

14.3 Method of Measurement. Unless otherwise provided, this work will be measured in the original position of the structures to be removed as follows:

Removing asphaltic concrete, Portland cement concrete and other similar pavements will be measured by area in square yards. Where removal of curb, or curb and gutter is required in conjunction with the removing of surface or base course, these structures will all be classed as removing surface course, or base course and will be measured by area in square yards. Unless otherwise provided, any items for the removal of pavement shall include the removal of all pavement as directed on the plans or ordered by the engineer, irrespective of the type or number of surface or base courses encountered.

Removing of curb or curb and gutter which is separate from and not removable in conjunction with roadway surface or base courses, will be measured by length in linear feet, measured along the face of the curb.

Removing sidewalk will be measured by area in square yards.

Removing masonry structures, except headwalls, will be measured by volume in cubic yards.

Removing fence, including gates, will be measured by length in linear feet, center to center of end posts. If the proposal contains no item for "Remove Fence" removal of short sections, not exceeding one hundred fifty (150) feet in length shall be considered as included in compensation for other items of the work; if any section exceeds one hundred fifty (150) feet in length, the removal shall be paid for as "Extra Work".

Removing pipe culvert headwalls will be measured as units.

Removing or moving utility poles, removing manholes and drop inlets will be measured as units, including all attached parts and connections.

14.4 Basis of Payment. If the proposal includes a separate item and unit price for removing or otherwise disposing of any of the miscellaneous structures hereinafter listed, the accepted quantities of such items will be paid for at the contract unit price bid therefor.

The contract price, except as otherwise expressly provided, shall be full compensation for the removal and disposal of miscellaneous structures and for all material, labor, equipment, tools, supplies, storing materials, excavation, backfill, and incidentals necessary to complete the work.

Item	
Remove _____ Pavement	Square Yard
Remove Bituminous Surface	Square Yard
Remove Base Course	Square Yard
Remove Curb	Linear Foot
Remove Gutter	Linear Foot
Remove Sidewalk	Square Yard
Remove Curb & Gutter	Linear Foot
Remove _____ Masonry	Cubic Yard or Lump Sum
Remove Fence	Linear Foot
Remove Poles	Each
Remove Manholes	Each
Remove Drop Inlets	Each
Remove Headwalls	Each
Remove Headgates	Each
Remove Building (s)	Lump Sum or Each
Remove Concrete Siphon Wells	Lump Sum or Each
Move Building (s)	Lump Sum or Each
Abandon Manholes	Each
Abandon Drop Inlets	Each

If the proposal does not include a separate item for removing any of the miscellaneous structures listed herein, then removing such structure or structures shall be considered as included in the contract unit price bid per cubic yard

for "Roadway Excavation" and no additional compensation shall be allowed therefor.

Backfill and water will not be paid for directly, but the cost thereof shall be included in the various pay items of the contract.

If the proposal contains an item for moving a building or buildings, the contract lump sum for each work shall be full compensation for constructing new foundations, moving the building and setting on new foundations, repair of damage, if any, removal and disposal of foundation material on which building sat, storing surplus material or otherwise disposing of it as directed, moving the appurtenances of the building and for all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work.

SECTION 15 - ROADWAY AND DRAINAGE EXCAVATION

15.1 Description. This item shall consist of all work involved in the grading and construction of the roadway, excavating ditches and stream channels, the satisfactory disposal of all excavated materials, all work necessary for the construction and completion of embankment, slopes, ditches, stream channels, dikes, approaches, driveways, parking areas, service highways, ramps, and intersecting roads, and all subsidiary work for which separate items in the proposal are not provided; all in accordance with these specifications and in conformity with the alignment, grades and typical cross-section shown on the plans and staked by the engineer.

This item shall also include the removal and disposal of structures which encroach upon or otherwise obstruct the work when a separate item (or items) is not provided in the proposal for such removal and disposition.

This item does not include material obtained from borrow deposits either within or outside the right-of-way limits, nor does it include structure excavation.

15.2 Classification. Classification of roadway excavation shall not be made on the basis of materials encountered. Classification may be made by dividing the roadway transversely into sections and designating the classification within any section as "Roadway Excavation A" or "Roadway Excavation B" etc. When such classification is made, the designation of each section shall be shown on the plans and such designation shall not be changed regardless of the character of material encountered.

15.3 General Requirements. Before breaking ground, clearing and grubbing shall be completed in accordance with Section 12 of these specifications.

All excavation shall be made true to lines and grades staked by the engineer and shall be so conducted as to avoid removing or loosening any material outside the required slopes, and any material so disturbed shall be replaced and/or thoroughly compacted to the required cross-section.

All suitable material removed from the excavation shall be used as far as practicable in the formation of embankments, subgrade, shoulders, slopes, dikes and backfill for structures, unless otherwise indicated on the plans or ordered by the engineer. No excavated material shall be wasted without permission. When such material is to be wasted, it shall be disposed of in a satisfactory manner, where directed.

Intersecting roads, service highways, ramps, approaches and driveways shall be graded as shown on the plans or as directed.

The work done under this section shall begin at some definite place, or places, on the project, and be carried forward in an approximately completed manner. The roadway shall be graded to full cross-section width before placing base or surfacing of any type, unless otherwise provided.

During construction of the roadway, the roadbed shall be maintained in such condition that it will be well drained at all times.

Rev.

15.4 Waterways. All ditches and stream channels shall be constructed as shown on the plans or otherwise ordered and shall be excavated true to line and grade as staked by the engineer. In going from cut to fill, the roadway ditches shall be cut to the right or left before reaching the fill so as to avoid damage to embankments by erosion.

All suitable material from inlet or outlet intercepting ditches, from F.B. ditches or stream channel changes shall be used in the construction of the roadway as far as practicable, in dikes, or otherwise disposed of as shown on the plans or as directed.

V-type ditches shall be formed to the cross-section and dimensions shown on the plans by means of suitable equipment which will deposit all loose material on the downhill side so that the bottom of the finished ditches shall not be less than two (2) feet six (6) inches below the crest of the loose material piled on the downhill side.

To avoid destruction of natural growth during the construction of ditches, stream channels or dikes, travel of equipment shall be confined to the area within construction limits, except that turn-arounds may be permitted at points where they will not present an objectionable appearance from the roadway, and provided also that such turn-arounds shall not be located within two hundred (200) feet of the highway or at the end of the ditch or channel as the case may be, on ditches that are not parallel to the roadway, nor shall they be closer than two hundred (200) feet apart in parallel ditches.

15.5 Disposing of Loose Rocks and Boulders. All loose rock and boulders occuring within the construction limits not required for other construction included in the contract, shall be broken into such sizes that insofar as possible they can be placed in the specified layer thicknesses of embankments. The voids of all rocks so placed shall be filled with satisfactory excavated material.

The contractor shall not be required to break rocks and boulders into sizes of less than two (2) feet in smallest dimension.

All rocks and boulders that cannot be incorporated in the work by placing in embankments or used as riprap or for other purposes shall be disposed of by the contractor, either by burying in the ground within the right-of-way, in a manner approved by the engineer, or by placing at sites provided by the contractor outside the right-of-way and out of sight of the highway. If buried, the tops of rocks and boulders shall be not less than twelve (12) inches below natural ground level. If disposed of outside the right-of-way, the contractor shall obtain the written permission of the owner of the property upon which the material is to be placed. A copy of the permit shall be filed with the engineer. The piles shall be kept free from material other than rocks and boulders and shall be piled in a neat and orderly manner.

15.6 Excavations Below Grade. (a) Where solid rock is encountered in excavation for the roadbed and unless otherwise shown on the plans or directed it shall be loosened and broken up between the limits of the shoulder slopes so that no solid ribs, projections or large fragments will be within six (6) inches of the surface of the subgrade.

When directed by the engineer, the material thus broken up shall be removed and disposed of and the resulting space refilled to the required subgrade

elevation with an approved material.

The final surface of the rock shall be left so that it will drain adequately and where pockets are formed which will not drain, the contractor shall, at his own expense, provide drainage by trenching from the pocket or pockets to the bottom of the roadway ditch and backfill both the pocket and trench with a fragmentary rock, gravel or other suitable granular material.

In solid rock excavation, slopes shall be constructed to the average neat lines staked by the engineer. No rock shall project or overhang more than twelve (12) inches from the true slope.

(b) Any unstable material encountered in the roadway prism, such as muck, sod, silt, soft clay, swampy material or material which cannot be properly consolidated shall be removed, disposed of and replaced with an approved material as shown on the plans or as directed by the engineer.

(c) At grade points all undesirable top soil shall be excavated between the shoulder slopes, to a depth of eighteen (18) inches below profile grade to such distance into the cut as the engineer may direct. The undesirable top soil, shall be placed in the bottom of the adjacent embankment at least eighteen (18) inches below subgrade or placed where directed by the engineer.

(d) All areas excavated below subgrade shall be refilled with the best material available from excavations or from sources of borrow or aggregate.

This material shall be placed and compacted in accordance with the applicable requirements for "Embankment".

15.7 Blasting. The contractor shall exercise care in blasting not to overshoot and shall be required to remove, at his own expense, any material outside the staked slopes or grade which may be shattered or loosened by overshooting during blasting, except that for unavoidable overbreak in solid rock excavation an allowance will be made as hereinafter set forth.

The engineer shall be sole judge as to whether or not overbreak was unavoidable.

The contractor shall employ only thoroughly experienced and competent personnel who are expert in the problems of spacing and depth of drill holes, selection and kind of explosive and manner of loading, methods of firing and kindred matters.

The engineer shall have authority to require the contractor to discontinue any method of blasting which results in breaking or loosening material outside staked slopes or grade, or is dangerous, or is destructive to property or landscape. He shall also have authority to permit only light shooting, with a few holes, containing small charges being shot simultaneously in areas he deems conditions warrant such practice.

The use of coyote holes in blasting is prohibited.

15.8 Slides. Slides extending beyond the staked slope lines shall be removed and placed in embankments or otherwise disposed of as directed by the engineer. The slopes shall then be cut to new lines established by the engineer for the purpose of eliminating, insofar as is feasible, any unsightly appearance

caused by the slide.

15.9 Widening Cuts. When so ordered by the engineer, cuts shall be widened and cut slopes flattened over the widths and slopes originally staked to obtain materials for completing embankments.

15.10 Reserved Material. When, in the opinion of the engineer, certain material encountered in excavation should be reserved for finishing, such material shall be saved for this purpose. If feasible, this material shall be left in place until it can be hauled direct to where needed, but if this is not feasible, it shall be excavated, stockpiled, and later used for finishing.

15.11 Slopes. All slopes, except in solid rock, shall be trimmed accurately to the lines staked by the engineer. The degree of smoothness shall be that normally obtained by hand shovel operations. A hand raked, "sand paper" finish is not required. Rock slopes shall conform as nearly as possible to the required lines and shall be free from decided humps and holes. Such slopes shall be scaled and all loose material removed.

15.12 Method of Measurement. The volume of roadway and drainage excavation to be paid for shall be the number of cubic yards, measured in its original position by the method of average end areas with no correction for curvature, of all excavation completed and accepted under this section, which yardage shall include all surface boulders and unsatisfactory material, slides, and overbreak, authorized for removal and payment, all limited as provided herein and as follows:

(a) Excavations within the lines, grades and cross section indicated on the plans or staked by the engineer.

(b) Solid rock or other material requiring blasting actually removed as directed below the surface of the subgrade. No measurement shall be made of any material removed if the space is refilled before the engineer takes the necessary measurements.

An allowance will be made for material loosened and broken up and not removed. This allowance shall not exceed the amount which would be obtained if material was actually removed to a depth of six (6) inches below subgrade between the limits of the shoulder slopes.

(c) Overbreak (breakage beyond the finished excavation as planned) if not caused by improper methods of excavation such as unnecessarily heavy charges during blasting, in an amount equal to fifty (50) percent of that actually occuring outside the staked slopes, or when occuring below the subgrade surface an amount equal to twelve (12) inches in depth, below the subgrade surface, for the full width of

the roadway between the limits of the shoulder slopes.

(d) Slides (slides beyond the finished earthwork as planned) if not caused by improper methods of excavation, such as improper drainage, undercutting material, or improper slope construction.

(e) Excavation of muck, silt, soft clay, sod, swampy material, or other soft or yielding material when shown on the plans to be removed or where ordered by the engineer.

All excavation for ditches and stream channels having a bottom width of less then eight (8) feet shall be classified as drainage excavation. All excavation for ditches and channels having a bottom width of eight (8) feet or more shall be classified as roadway excavation. There shall be no distinction in classification on account of placing ditch or stream channel excavation either in dikes or within the roadway prism.

V-type ditches shall be measured in linear feet of ditch and each one hundred (100) feet shall constitute a unit of one station. The volume of excavation for such ditches shall not be measured.

15.13 Basis of Payment. The following construction operations shall be paid for at the contract unit price bid per cubic yard for "Roadway Excavation" or for "Roadway Excavation A", and "Roadway Excavation B", as the case may be, for the quantities of material involved and no additional compensation will be allowed therefor:

Excavating the roadway prism, including existing bases and bituminous pavements and surfacings; widening cuts; excavating reserved material and rehandling such material from stockpiles when stockpiling is ordered; excavating and disposing of unsuitable materials; loosening and breaking up rock or a mixture of rock and earth within six (6) inches of the surface of the subgrade in cut sections, whether the material is removed or not; removing unpreventable slides and overbreak not resulting from overshooting; excavation of F.B. ditches and stream channels having a bottom width of eight (8) feet or more; all as shown on the plans, or specified or directed by the engineer.

The excavation of F.B. ditches and stream channels having a bottom width of less than eight (8) feet shall be paid for at the contract unit price bid per cubic yard for "Drainage Excavation".

The excavation of V-type ditches shall be paid for at the contract unit price bid per station for "V-Type Ditches".

The above payments shall include full compensation for furnishing all labor, materials, tools, supplies and doing all the work involved in excavating, loading, hauling, depositing and spreading or disposing of the excavated material as shown on the plans or directed by the engineer and in accordance with the requirements of this section except that clearing shall be measured and paid for as specified in Section 12 and overhaul shall be measured and paid for as specified in Section 19.

Full compensation for constructing embankments; earth dikes adjacent to F.B. ditches and other locations; refilling spaces resulting from the removal of unsuitable material with approved material; backfilling excavated areas resulting from the removal of structures and drainage facilities; placing reserved roadway excavation as finishing for the top portion of the graded roadbed; placing reserved material and topsoil in stockpiles as specified; all as shown on the plans or directed by the engineer and as specified, shall be considered as included in the contract price paid per cubic yard for roadway excavation or drainage excavation for excavating the material or the contract price paid for furnishing the material, as the case may be, and no additional compensation will be allowed for such work, except that watering and overhaul ordered by the engineer will be measured and paid for as provided in Sections 19 and 28 respectively.

SECTION 16 - BORROW

16.1 Description. This item shall consist of excavating and placing material required to complete the embankments, roadbed, shoulders, intersections, approaches, entrances, and protection dikes, when sufficient quantities of suitable material for such purposes cannot be obtained from within the limits of "Roadway and Drainage Excavation", "Structure Excavations", and other designated excavation, and when such additional material is obtained from deposits or pits outside the right-of-way limits.

16.2 Materials. Borrow shall be obtained from sources designated on the plans or otherwise approved. The material furnished under this item shall consist of soil or a mixture of natural soil-aggregates which are of a character and quality satisfactory for the purpose intended. The contractor shall obtain the best material from such source, and it shall be free from sod, stumps, logs, roots, or other deleterious matter.

16.3 Construction Methods. Borrow shall not be obtained until all other excavation items are complete to the extent necessary to determine the need for borrow. The area in which material for "Borrow" will be obtained shall be cleared and grubbed in conformity with requirements in Section 12 and all grass, weeds, roots, and other vegetable matter shall be removed and properly disposed of.

The contractor shall notify the engineer sufficiently in advance of the requirements of any borrow excavation to permit the accurate measurements of the borrow pit, and any material removed before such measurements have been taken will not be paid for.

Borrow pits shall be excavated to regular lines as staked to permit accurate measurement. The dimensions of the borrow pits will be designated and the contractor shall not excavate below the depth or outside limits given except with prior approval. The depth of excavation throughout the area of the borrow pits shall be as uniform as practicable and the side slope shall be dressed to such slope as may be directed. Unless otherwise permitted, borrow pits shall be excavated so that they will drain to the nearest natural outlet.

All materials which are not satisfactory for use for the purposes intended shall be rejected at the pit and disposed of as directed by the engineer.

If the contractor excavates more material than is required, the excess will not be measured for payment.

The engineer reserves the right to replace proposed borrow by requiring the contractor to haul excess material from any point as excavated, and to place such excavated material, including structure excavation, and excavation from ditches in the embankment with no additional compensation except that payment will be made for authorized haul.

All work and materials required to build and maintain borrow haul roads shall be at the sole expense of the contractor.

16.4 Method of Measurement. Borrow will be measured by the cubic yard in its original position, computed by the method of average end areas, of material

acceptably excavated, including unsuitable material disposed of as directed by the engineer. All excavated borrow material in excess of that required for or not incorporated in the work will not be included in the quantity measured for payment.

16.5 Basis of Payment. The quantity of borrow, measured as provided above, and acceptably placed in the work, shall be paid for at the contract unit price bid per cubic yard for "Borrow", which payment shall be full compensation for furnishing, excavating, loading, and placing the material, and for all labor, equipment, tools, supplies, and incidentals necessary to complete the work specified.

Clearing shall be measured and paid for as specified in Section 12, "Clearing and Grubbing".

Haul in excess of the free haul shall be paid for as provided in Section 19, "Overhaul".

When borrow is required and the item does not appear in the proposal it shall be paid for as roadway excavation.

SECTION 17 - SELECTED BORROW

17.1 Description. This item shall consist of excavating and placing selected granular materials in one or more courses for subgrade in accordance with these specifications and in conformity with the lines, grades and the typical cross sections shown on the plans or as directed by the engineer.

17.2 Materials. The material shall be obtained from sources indicated on the plans, designated in the special provisions, or as directed by the engineer.

The contractor shall be required to obtain the best material available from the source designated.

Selected borrow shall conform to the size and quality requirements prescribed in the special provisions and if size and quality requirements are not prescribed therein, the material shall consist of naturally occuring granular material such as pit-run gravel, sand, decomposed granite, or slide rock and shall be free from wood, roots and bark, but shall contain sufficient sand or filler to permit compaction of the subgrade. The maximum size of this material shall not be greater than two-thirds the compacted thickness of the course. When the sources of selected borrow are designated in the special provisions or indicated on the plans, the contractor may, after properly stripping the pit, place the naturally occuring material directly on the roadway without further treatment other than the removal of oversized stones, blading or processing to secure uniformity, and watering and rolling as may be required. Oversize material, either loose or partly buried greater than three (3) inches in largest dimension shall be removed from the surface of the roadbed and shall be disposed of as directed.)

The contractor shall use necessary precautions in loading selected borrow to insure reasonable uniformity in grading, and the inclusion of such portions of binder material as directed.

17.3 Construction Methods. Unsuitable overburden shall be stripped to the required depth and be disposed of as directed by the engineer. The selected borrow shall be excavated to the lines and grades set by the engineer.

The contractor shall supply and use suitable equipment capable of working the pit face to obtain uniform gradation and mixture of pit material.

The surface of the subgrade upon which the selected borrow is to be placed shall conform to the established lines and grades and shall be reasonably smooth and uniform.

The material shall be evenly spread over the surface of the subgrade to such depth that when compacted it shall have the thickness shown on the plans or as ordered. The material as placed on the subgrade shall be processed and respread to insure the elimination of hard spots and to secure a uniform mixture and compaction.

Compaction shall be secured by the application of water and rolling as required.

17.4 Method of Measurement. Selected borrow shall be measured by the

cubic yard in its original position by the method of average end areas, or the ton determined in accordance with the requirements of Section 9 "Measurement and Payment".

The quantity to be paid for shall be the quantity actually used in the roadway and will not include overburden or material not suitable for the purpose intended or for material placed outside staked lines and grades of the roadway prism.

17.5 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price bid per ton or per cubic yard for "Selected Borrow", which payment shall be full compensation for all labor, materials, tools, supplies, equipment, and doing all the work involved in clearing, grubbing and stripping the borrow site if necessary; excavating and processing the material to conform to the specified size and/or quality requirements; loading, hauling, including any overhaul; and spreading the material on the roadbed as specified.

Watering, ordered by the engineer, shall be measured and paid for as provided in Section 28.

Rolling, as ordered by the engineer, shall be measured and paid for as provided in Section 29.

SECTION 18 - ROUNDED AND TRANSITION SLOPES

18.1 Description. This item shall consist of rounding and shaping slopes, when required, in accordance with the typical cross sections shown on the plans or ordered by the engineer.

18.2 Construction Methods. The top of cut slopes shall be rounded by excavating to blend the cut slopes with the adjacent natural terrain. Embankment slopes shall be rounded by filling the bottoms of the embankments to blend with the natural ground surface. At the intersection of cuts and fills, slopes shall be adjusted and warped to blend into each other or into the natural ground surface without noticeable break.

Slopes will be staked for flattening and rounding in places where the material is other than solid rock. Rock formations, such as shales, decomposed sandstone and granite that can be readily excavated by means of hand tools, shall have the slopes flattened and rounded the same as earth slopes. A layer of earth overlying a rock cut shall be rounded above the rock the same as earth slopes. Where the depth of cut or fill is insufficient to provide the full rounding required, the distance for rounding shall be proportionately adjusted.

Final trimming of rounded and transition slopes shall be done after the earthwork, drains, and structures have been substantially completed and after the structures have been backfilled.

Slope rounding and warping shall also apply to all drainage ditches when such rounding will improve the appearance of the roadside.

Whenever the treatment of the slopes may destroy or injure standing timber, trees, or other vegetation which should be preserved, adjustments in slope grading will be made by the contractor as directed by the engineer. These adjustments shall be effected by a gradual transition from the theoretical grading section required.

The degree of smoothness required in rounding and warping slopes shall be as specified in Article 15.11, of these specifications.

18.3 Method of Measurement. The quantity of rounded or transition slope to be paid for shall be measured in linear feet of slopes, treated as specified, measured along the roadway ditch each side of the roadway centerline, and each one hundred (100) feet shall constitute the unit of one station. Rounding of shoulders or bottoms of side ditches, when required, shall not be measured for payment.

18.4 Basis of Payment. The quantity, measured as provided above, shall be paid for at the contract unit price bid per station for "Slope Rounding", which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

In addition to the payment specified above, the quantity of excavation required shall be measured and paid for as prescribed in Section 15.

SECTION 19 - OVERHAUL

19.1 Description. This item shall consist of the transportation of roadway excavation and borrow when the gross haul exceeds the free haul. The limit of free haul shall be fixed at five hundred (500) feet.

19.2 Method of Measurement. When separate payment is provided, overhaul shall be measured by the yard station or by both the yard station and the yard mile. A yard station shall be one (1) cubic yard hauled one hundred (100) feet. A yard mile shall be one (1) cubic yard hauled one (1) mile. Computation of overhaul shall be made by means of a mass diagram when practicable.

Except as provided below, measurement shall be made by the yard station and the overhaul distance shall be the distance, less five hundred (500) feet, between the center of volume in original position and the center of volume after placing. The number of yard stations shall be the product of the volume of the overhauled material, measured in its original position, and the overhaul distance.

When proposal items are included for both yard station and yard mile overhaul, overhaul for the first one thousand (1000) feet shall be measured in yard stations as specified above. In addition, overhaul on the portion of the gross haul in excess of one thousand (1000) feet shall be measured in yard miles and the overhaul distance shall be the distance, less one thousand (1000) feet, between the center of volume in original position and the center of volume after placing. The number of yard miles shall be the product of the volume of the overhauled material, measured in its original position, and the overhaul distance.

Gross haul shall be measured along the centerline of construction in the case of roadway excavation and along the shortest feasible route as determined by the engineer in the case of borrow.

Overhaul shall be computed only on the volume of acceptable roadway excavation and borrow paid for as specified in Sections 15 and 16.

19.3 Basis of Payment. Unless an item is included in the proposal, the contract unit price per cubic yard for roadway excavation or borrow shall be considered as including payment for overhaul.

When an item of overhaul is included in the proposal, the quantity or quantities measured as provided above, shall be paid for at the contract unit price bid as follows:

Per yard station for "Overhaul, Yd. Sta." ~~or per yard station for "Overhaul, Yd. Sta.~~" and per yard mile for "Overhaul, Yd. Miles" as the case may be, which price or prices shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

20.1 Description. This item shall consist of constructing stable well-compacted embankments (fills), including the preparation of the ground areas upon which they are to rest; the placing of approved materials within the roadway areas where unsuitable embankment foundation material has been removed; the construction of earth dikes; and the placing of embankment material in holes, trenches, pits and other depressions within the roadway prism; in accordance with these specifications and conforming to the lines, grades and typical cross-sections shown on the plans and staked by the engineer.

20.2 Foundation. All foundations for embankment shall be reasonably free from organic material such as leaves, grass, roots, and wood. Vegetation of a height greater than one (1) foot shall be cut and properly disposed of before embankment is placed thereon. Heavy sod and other perishable material shall be removed from within the area of the roadbed and other unstable material shall be removed and disposed of or otherwise treated as shown on the plans or as directed by the engineer.

The relative compaction of the natural ground area upon which embankments are to be constructed, where embankments are five (5) feet or less in height, shall not be less than ninety (90) percent. When necessary to conform to this compaction requirement, the natural ground area within the embankment limits shall be plowed, rooted or scarified to a depth of not less than six (6) inches, adequately moistened and compacted. Compaction of the natural ground to conform to the above specified requirement shall be performed as hereinafter specified for compacting embankment materials.

Ice and snow shall be removed from the surface of the ground prior to the placing of embankment thereon, however if subsurface materials are frozen, operations shall be suspended.

Where embankment is to be constructed on a hillside, the natural ground surface within the embankment area shall be stripped of sod and humus and shall then be plowed and scarified, or when the nature of the material in the hillside slope is such that it is hard and smooth, it shall be benched or terraced as may be necessary to adequately key the existing ground and the embankment built thereon.

Where embankment is to be constructed against existing embankments or where embankment is to be constructed one-half (1/2) width at a time, the slopes of the old embankment or new fill shall be cut into or benched as the new embankment is brought up in layers. Material thus cut out shall be spread and incorporated in the new fill as part of the embankment construction.

The cost of all such benching, plowing, rooting, scarifying or terracing shall be considered as included in the various pay items of the contract, and no direct payment shall be allowed unless otherwise specifically provided on the plans or in the special provisions.

Where embankments are to be constructed across low swampy ground, which will not support the weight of the hauling equipment, the lower part of the embankment may be constructed by end dumping to form a uniform layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers. The remainder of such embankments shall be constructed in layers and compacted as hereinafter specified.

If embankment is to be placed over an existing bituminous surface, the top of which is twelve (12) inches or less below the subgrade elevation of the proposed new pavement, the existing roadway shall be loosened to a depth of not less than twelve (12) inches. This loosened material shall be spread uniformly over and compacted for the full width of the subgrade plus one (1) foot on each side. No direct compensation shall be allowed for this loosening, spreading, and compacting, but the cost thereof shall be included in the various pay items of the contract.

If the embankment is to be placed over an existing bituminous surface, the surface of which is more than twelve (12) inches but less than three (3) feet below the subgrade elevation of the proposed new pavement, the existing surface shall be loosened to a depth sufficient to prevent possible trapping of water above the existing surface. No direct compensation will be allowed for this loosening, but the cost thereof shall be included in the various pay items of the contract.

20.3 Materials. Embankments shall be constructed with suitable materials excavated as prescribed in Section 15 or Section 16, and with any excess materials from other operations which are acceptable and suitable for use.

All materials used in embankment shall be free from objectionable material such as leaves, grass, roots, logs, stumps, brush, or other perishable material.

When there is a choice of material and when practicable, the excavation shall be made so that the best material will be placed on top of the embankment for at least one (1) foot in depth. This paragraph shall not be interpreted as to require the contractor to stockpile and subsequently rehandle embankment material except as provided in Section 15.

No materials shall be placed in the embankment when either the material, foundation, or the embankment on which it would be placed is frozen.

20.4 Construction Methods. (a) General. Fine material suitable for finishing shall be placed on top. Except as otherwise provided below, clods or hard lumps over six (6) inches in greatest dimension shall be broken up before compacting the material in the embankment. Rocks or lumps of hardpan, cemented gravel, or similar material which cannot be broken readily shall be well distributed throughout the embankment and sufficient earth or other fine material shall be placed around the large material as it is deposited in order to fill the interstices and produce a dense compact embankment.

Sod, mixed with satisfactory soil or humus bearing soil, shall be placed on the slopes. When ordered by the engineer or shown on the plans, sod and humus bearing soil shall be hauled and distributed uniformly over slopes of rock embankments or otherwise disposed of.

Clay, silt, and other high shrinkage materials shall be deposited at the bottom of the fill and in no case shall such material be placed in embankment within two (2) feet of the finished grade.

Embankments shall be constructed so that after compaction they will conform to the lines, grades and typical cross sections shown on the plans and staked by the engineer.

The filling around and over culverts and other structures in the embankment area shall be completed before the embankment is started. It shall be performed as a separate operation with the fill material placed in thin layers and thoroughly compacted by means of rollers, mechanical tampers, and hand tools in accordance with Section 22 "Backfill". The structures shall be covered sufficiently to protect them from damage from equipment or rolling rocks during the embankment construction.

Where embankments are to be made of material from rock cuts or other material which is unsuitable for finishing the roadbed, the upper six (6) inches of the roadbed shall be formed of approved material.

If material required for the formation of the roadbed embankment is wasted by the contractor, contrary to these specifications or to the orders of the engineer, the contractor shall replace at his own expense such wasted material with other approved material.

No fill shall be placed against any new masonry, abutment, wing walls, retaining walls or culverts or over any culvert, bridge, or arch until permission shall have been given by the engineer. Filling around culverts, bents, and piers, and fill placed below the natural ground surface at abutments, wings, and retaining walls shall be deposited on all sides to approximately the same elevation at the same time. Filling at arch structures shall be carried up in horizontal layers, symmetrical from the haunch to the crown and simultaneously over all piers, abutments, and arch rings. Special precautions shall be taken to prevent wedging action of filling material against structures. If the engineer directs, the backslopes of excavation shall be destroyed by stepping or serrating.

(b) Placing Layers. Embankments shall be constructed in layers not exceeding the depth indicated herein and parallel with the finished grade for the full width of the embankment.

Embankments built of soil, granular material or shale (rolled embankments) shall not exceed eight (8) inches in thickness before compaction.

When embankments are built of a mixture of rocks, boulders, granular material, said materials shall be placed, if practicable, so that the larger particles of material are placed near the outer slopes and the finer material near the center of the roadway. The fine materials shall be incorporated in the embankment as set forth above for rolled embankment, and the larger materials shall be placed as specified for rock embankment. However, if there is a preponderence of large rock and boulders, an embankment of above material shall be constructed in uniform layers placed across the entire width of the embankment prism. The thickness of the layers will be dependent on the size of rock or boulders but shall not exceed thirty-six (36) inches in depth and shall be compacted to the maximum compaction obtainable by routing the loaded hauling equipment over the entire width of the layer, supplemented by the use of approved rollers.

(c) Placing Rock. To the extent of project requirements for embankment all rock from excavation shall be used for embankment. The contractor shall plan his grading operation to use rock which may be encountered in excavation in accordance with the following provisions:

Rock, in general, shall be placed so as to form the base of embankment for the full width of the cross section; on the side slopes or slopes of a new embankment being placed; on the side slopes or slopes of an embankment already in place requiring widening or where excess rock may be wasted; or on the side slopes and top of rolled embankment made of embankment materials other than rock.

Before any rock fill is superimposed upon a rolled embankment, the top shall be sloped from the center to the sides at the rate of approximately one (1) inch per foot, and all loose material shall be thoroughly compacted. Rock shall be placed in such a manner that water can drain from voids contained therein.

Rock fills shall be placed in not to exceed three (3) foot layers and unless otherwise ordered, need not be rolled. Rock which cannot be incorporated into three (3) foot layers shall be reduced in size until it can be so incorporated. Care shall be exercised in placing rock so that the side slopes will conform substantially with the requirements of the plans.

When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portions of the embankment as rock fill and the other material shall be incorporated into the inner portions as rolled embankment. Rolled embankment adjacent to rock fills shall be held at substantially the same elevation as the rock but always above the work and of sufficient width to permit the proper compaction of this portion. In all rock slopes the rock shall be placed with the larger rocks at the outer base and the smaller rocks installed near the rolled embankment.

When there is insufficient material other than rock in the excavation to permit properly compacted layers, the rock shall be placed for the full cross section width with the larger rocks well distributed and the void spaces filled with the smaller rocks and fragments.

Where structures are located under a rock embankment, they shall be covered with not less than two (2) feet of satisfactory soil or granular materials from the excavation before the embankment is placed over the structure.

20.5 Compaction. Compaction of embankments shall be done with approved pneumatic-tired rollers, multiple-smooth-wheeled powered rollers, or self-cleaning tamping rollers conforming to the requirements set forth in Section 29 "Rolling". The type of roller used shall be suited to the character of soil in the embankment. Types found unsuitable, after trial, in obtaining thorough compaction shall be replaced by another type when so ordered by the engineer.

The contractor shall provide at least one tamping roller of not less than two units and one pneumatic-tired roller for each three hundred (300) cubic yards or fraction thereof, of material placed an hour. The quantity of material placed per hour shall be determined by averaging the total quantity of material placed in one (1) day or one shift of operation, measured in excavation. Where tamping type rollers are used, the contractor shall be permitted to use two (2) rollers of two units for each four hundred (400) cubic yards of material placed in embankment per hour.

The rolling equipment shall be used when and as ordered by the engineer, until the required compaction is obtained, and the selection of type shall be at the discretion of the engineer. The roller shall be so operated that the compaction of each layer shall be uniform for the full width of the cross-section. The soil beneath each layer shall be stable enough to support without displacement the rolling specified for each succeeding layer.

Each layer of soil, granular material, or shale shall be leveled, rolled and thoroughly compacted to a relative compaction of not less than ninety (90) percent as determined by the compaction tests specified in Article 6.5 of these specifications.

Embankment material which is not sufficiently moist to compact shall be sprinkled with water as directed by the engineer, either during excavation or when being placed in embankment. If the embankment material is rock, sufficient water shall be applied to flush the fine particles into the interstices of the rock.

The moisture content of the embankment material at the time of compaction, shall be such that the density hereinbefore specified can be expediently obtained with the equipment being used.

At locations that are inaccessible to the roller, the embankment shall be brought up in layers of the thickness specified above and each layer shall be compacted thoroughly with mechanical tampers or by hand tamping.

The contractor shall provide and use sufficient equipment of the type and weight ordered to obtain the required compaction in all areas including those that are inaccessible to ordinary rolling equipment.

The top six (6)iinches of completed subgrade, in cuts shall be compacted to the same density as required for each layer of embankment.

When the proposal does not contain an item for "Rolling", compaction shall be obtained by routing the hauling and spreading equipment traffic over the embankment area in such a way that all portions of the layer are uniformly covered by the wheels and crawlers.

20.6 Maintenance. The contractor shall be responsible for the stability of all embankments made under the contract and shall bear the expense of replacing any portion which may have become misplaced due to carelessness or negligent work or failure to take proper precautions.

Embankments shall be maintained true to grade and cross section until the completion of the contract.

20.7 Method of Measurement and Basis of Payment. Embankment construction will not be measured or paid for directly, but is designated as a necessary part of the construction, and the contract unit prices bid for the materials with which embankments are constructed, shall be full compensation for the construction of embankments in accordance with the provisions and requirements as contained herein; and for furnishing all labor, material, tools, supplies, equipment, and incidentals necessary to complete the work except as follows:

(a) Sod and soft unstable materials excavated and removed from the foundation shall be measured and paid for as provided in Section 15, "Roadway and Drainage Excavation".

(b) Water, applied as ordered for use in embankment compaction, will be measured and paid for as provided in Section 28, "Watering".

(c) Rolling, when it appears an item in the proposal, will be measured and paid for as specified in Section 29, "Rolling".

SECTION 21 - STRUCTURE EXCAVATION

21.1 Description. Structure excavation shall consist of the removal of all material of whatever nature encountered for the construction of foundations for bridges, retaining walls, headwalls for culverts, and other structures; the excavation of trenches for pipe and box culverts, cut-off walls for slope paving and concrete aprons, footings for riprap and other excavation specifically designated on the plans, in these specifications or in the special provisions as structure excavation, including the work of disposing of supplus material and cleaning up the sites. Structure excavation shall inclidde the furnishing of all equipment and the construction or installation of all cofferdams, cribs and other facilities which may be necessary to perform the excavations and the subsequent removal of such facilities except where they are required or permitted by the plans or specifications to remain in place. It shall also include all the necessary clearing and grubbing within the proposed structure area and removing old structures or parts thereof as required if the proposal does not include separate bid items for such work.

For specific requirements pertaining to the excavation involved in the installation of pipe culverts and underground piping, attention is directed to those sections of these specifications governing such work.

21.2 Classification. Classification of structure excavation will not be made on the basis of materials or conditions encountered. Classification of excavation, if made, will be on the basis of the material removed between certain elevations, and such classification as shown on the plans or set forth in the special provisions shall not be changed regardless of the material encountered.

21.3 General Requirements. The contractor shall notify the engineer a sufficient time in advance of the beginning of excavation for structures so that elevations and measurements may be taken of the existing ground before it is disturbed and of all existing substructure units within the limits of excavation for structures before they are removed. Any material excavated or removed before these measurements have been taken will not be paid for.

The excavated area shall conform to the outlines of the footings, as shown on the plans, and shall be of sufficient size to permit placing of the full width and length of the footings shown. The elevation of the bottoms of footings as shown on the plans shall be considered as approximate only, and the engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure a satisfactory foundation.

All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped, or serrated, as may be directed by the engineer. All seams and crevices shall be cleaned out and filled with concrete mortar or grout.

Where masonry is to rest on material other than rock or boulders, special care must be given not to destroy its bearing value and the final removal of the foundation material to grade shall not be made until just before the masonry is to be placed.

Except where a seal is provided for by the plans or ordered, wet pits

shall be unwatered for inspection and for construction of foundations.

Should the contractor remove foundation excavation below grade, he shall backfill to the required elevation at his own expense with concrete or with foundation fill, as directed by the engineer.

Where the existing foundation material is of such character it would not safely support the contemplated load, the engineer may direct that foundation piles be driven in the footing area. This piling shall be furnished, driven, and paid for under the provisions of Section 50.

Excavated material which is suitable for backfilling shall be so utilized or used in embankments, or for any combination of these as directed. Surplus or unsuitable material shall be disposed of so as to cause no obstruction to flow of streams; or otherwise impair the efficiency or appearance of the structure. It shall be disposed of as directed and in such manner as to prevent damage to property or the creation of unsightly conditions, and shall not be placed where it will interfere with the operation of trains or impair the roadway ditches, etc.

21.4 Cofferdams and Cribs. Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and as water tight as practical. The interior dimensions of cofferdams shall be such as to provide sufficient clearance for constructing forms and, when no seal is placed, to permit pumping outside the forms.

The contractor shall submit for approval drawings showing proposed method of construction of cofferdams or cribs. Approval of such drawings shall in no way relieve the contractor of his responsibility under the contract for the successful completion of the improvement. Cofferdam construction shall not start before the submitted drawings are approved and returned.

Cofferdams or cribs shall be constructed for all abutments and piers where water or unstable soil is encountered or where, in the opinion of the engineer it may become unstable. Cofferdams shall also be constructed to protect green concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams that would, in any way, extend into the substructure masonry, without written permission of the engineer.

Cofferdams which are tilted or moved out of position by any cause whatsoever during the process of sinking, shall be righted or enlarged so as to provide the necessary clearance and proper pier location and such work shall be at the sole expense of the contractor.

In streams at a time of probable flood, cofferdam walls shall be vented at low water elevation to insure full hydrostatic head both inside and outside of the cofferdam during the period of pouring and setting of seals.

After the completion of the substructure, the cofferdams with all sheeting and bracing shall be removed to the level of the stream bed, by the contractor, at his own expense and such removal shall be performed in such a manner as not to disturb or mar the finished concrete foundation.

21.5 Foundation Seal. When conditions are encountered which, in the opinion of the engineer, render it impracticable to unwater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary.

The foundation enclosure shall then be pumped out and the balance of the masonry placed in the dry. When weighted cribs are employed and the weight utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal.

21.6 Pumping. Pumping from the interior of any foundation enclosure shall be done in such manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping will be permitted during the placing of concrete or for a period of at least twenty-four (24) hours thereafter, unless it be done from a suitable pump separated from the concrete work by a water-tight wall or other effective means.

Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

21.7 Inspection. After each excavation is completed, the contractor shall notify the engineer, and no masonry shall be placed until the engineer has approved the depth of excavation and the character of the foundation material.

21.8 Backfilling. After the structure has been completed, the areas around the structure shall be filled with approved materials as required in Section 22, "Backfill".

21.9 Method of Measurement. The quantities of earth work to be paid for as structure excavation shall be the volumes in cubic yards computed in accordance with the following provisions:

The limits for payment of structure excavation shall be those shown on the plans or ordered by the engineer or hereinafter set forth and shall include such portions of the existing substructure units as are in those limits.

Excavation for foundations shall be bounded by the existing ground surface or existing substructure unit (the elevation of bottom of footing) and vertical planes eighteen (18) inches outside of and parallel to the neat footings, provided that if the engineer orders the excavation carried below the bottom of the footing for the purpose of constructing a foundation seal or placing a subfoundation course, such excavation shall be included in the volume measured for payment.

The quantity of excavation for pipe culverts, pipe culvert extensions and underground piping, will be the quantity actually removed but not to exceed the volume in place bound by the ground surface as it exists at the time when the excavation is started, the invert elevation of the pipe, and vertical planes twelve (12) inches outside of and parallel to the pipe, for pipes thirty (30) inches or less in diameter; and vertical planes eighteen (18) inches outside of and parallel to the pipe, for pipes thirty-six (36) inches or over in diameter, provided that the volume so measured for payment shall include only that portion not measured for payment as described above.

The upper limit for payment of structure excavation shall be as set forth

above with the following exceptions:

Where structure excavation is performed within the roadway excavation areas or ditch and channel excavation area, the upper limit shall be the planes of the bottom and side slopes of said areas excavated as shown on the plans or ordered by the engineer. Where it is required that the structure excavation be made in new embankment, the upper limit shall be the planes of the new embankment at the elevation shown on the plans or specified for construction in advance of performing the required structure excavation. When footings are founded in embankment areas, the upper limits shall be the surface of the embankment at the time the excavation is made but in no case shall the upper limit be above the planes of the new embankment shown on the plans.

21.10 Basis of Payment. The yardage, measured as provided above, shall be paid for at the contract unit price bid per cubic yard for "Structure Excavation", which payment shall be full compensation for all clearing, grubbing, cofferdams, cribs, sheeting, shoring, bracing, pumping and unwatering; for removing and disposing of all excavated material not included in bid items pertaining to the removal of existing structures; and for furnishing all material, labor, tools, equipment, and doing all the work involved to complete this item of earthwork.

When foundation fill is specified and furnished for refilling, it shall be measured and paid for in accordance with the pertinent provisions of Section 23, "Foundation Fill".

When a foundation seal or concrete mortar or grout is ordered by the engineer, the concrete masonry shall be measured by the cubic yard of volume in place as authorized by the engineer, and the quantity thereof so measured shall be paid for at the contract unit price bid for the concrete masonry in the adjacent footing.

No compensation will be made for the removal and disposal of material which may come into an excavation from outside the designated limits or for the removal and disposal of swell material resulting from the driving of piles in an excavation.

SECTION 22 - BACKFILL

22.1 Description. Structure backfill shall consist of placing and compacting, to the lines designated on the plans or as specified herein or ordered by the engineer, backfill material in foundation excavations for bridges, retaining walls, headwalls for culverts, and other structures; placing and compacting backfill material in trenches for culverts and pipes; and other backfill specifically designated on the plans or in these specifications or in the special provisions as structure backfill. (This item does not include backfilling minor miscellaneous structure excavations outside the limits of the roadway.) clarify for items outside R/W etc., Al.K. - RE. - M.E. Culverts are not considered minor.

22.2 Materials. Material for use as structure backfill shall be selected material obtained from the excavation for the structure, from roadway and drainage excavation or other designated areas. The structure backfill material shall be free from stones or lumps of material exceeding three (3) inches in greatest dimension and shall be free from sod, frozen earth material, and organic materials.

If suitable replacement material is not found in the excavations set forth above, it shall be materials conforming to the requirements for selected borrow, selected material surface or gravel base courses, whichever appears as an item in the proposal and it shall be measured and paid for as provided in that item.

22.3 General Requirements. Compaction of backfill or embankment around all structures shall be secured with mechanical tamping units and the material shall be placed at a rate which will permit efficient use of mechanical tampers in securing the required compaction. The mechanical tamping units shall be approved air, gasoline or electric driven tampers. Adequate power and incidental equipment shall be supplied to operate the tamper units efficiently to compact the material to the requirements specified.

Backfill material shall be placed in uniform horizontal layers not exceeding four (4) inches in loose thickness before compaction and shall be brought up uniformly on all sides of the structure or improvement in order to avoid bending or distortional stresses. Each layer of backfill shall be moistened as directed by the engineer and thoroughly tamped until the relative compaction is not less than ninety (90) per cent. Compaction of backfill material by ponding or jetting will not be permitted.

Material resulting from structure excavation and not used as structure backfill shall be deposited in roadway embankments in accordance with the requirements specified elsewhere or otherwise disposed of along the roadway as directed by the engineer and no additional compensation will be allowed for such work.

Structure backfill shall not be placed until the structure or facilities have been inspected by the engineer and approved for backfilling. No backfill material shall be deposited against the back of concrete abutments, concrete retaining walls, or the outside walls of concrete box culverts until the concrete has developed a strength of two thousand five hundred (2500) pounds per square inch in compression, as determined by test samples cured under conditions similar to those prevailing at the site and tested in accordance with the standard methods in use in the laboratory.

Where backfill is placed against waterproofed surfaces, care shall be taken that no damage is done to the waterproofing material.

22.4 Placing at Abutments, Piers, Wingwalls and Retaining Walls. Immediately after the removal of forms and with the approval of the engineer, all spaces excavated and not occupied by abutments, piers, or other permanent work shall be refilled with earth up to the surface of the surrounding ground or to the limits designated on the plans or as described herein. All backfill shall be thoroughly compacted in accordance with the provisions given above.

Special precautions shall be taken to prevent any wedging action against any masonry or walls, and the slopes bounding the excavations for abutments, wing walls and other permanent work shall be destroyed by stepping or serrating to prevent such wedging action.

22.5 Placing at Culverts. After the bedding has been prepared and the culverts installed or constructed as required by the pertinent specifications, selected material from excavation or from other sources shall be placed along both sides of the culvert equally in uniform layers not exceeding four (4) inches in depth (loose measurements), wetted as required and thoroughly compacted with mechanical tampers so that on each side of the culvert there shall be a berm of thoroughly compacted material at least as wide as the external diameter of the pipe culvert or outside vertical height of the RCB culvert, except as insofar as undisturbed material obtrudes into this area.

Special care shall be taken in placing and thoroughly compacting the material under the haunches of all pipe.

Unless otherwise directed the backfilling shall continue as described to the level of the ground or to an elevation six (6) inches above the structure in the case of a pipe culvert in projection, or even with the top of the structure in the case of an R.C.B. culvert in projection.

No construction or other traffic shall be permitted to cross any culvert until a safe minimum depth of fill above the culvert has been placed and consolidated in accordance with these specifications. The contractor shall be solely responsible for protecting the structure from superimposed loading created by construction equipment or otherwise and shall repair any damage done to the structure or replace the structure as ordered without extra compensation.

Special care shall be taken in backfilling arches particularly half circle arches. The arch shall be covered in layers, each layer conforming to the shape of the arch and tamped thoroughly.

22.6 Method of Measurement. When the item of backfill is included in the proposal, the quantity to be paid for shall be the number of cubic yards of compacted material in place in the completed and accepted work, limited as follows:

(a) For that portion below the top limits of structure excavation, the volume shall be that measurement for structure excavation less the volume of the structure therein.

(b) For that portion above the top limits of structure excavation:

For full circle pipe culverts:

The volume to be measured shall not exceed the vertical dimension bounded by the original ground surface, and a horizontal plane six (6) inches above the crest of the pipe; and the horizontal dimension shall be determined by the distance between vertical planes, equal to the diameter of the barrel of the pipe times three, but not in excess of the diameter plus ten (10) feet.

For arch pipe culverts:

The volume to be measured shall not exceed the vertical dimension bounded by the original ground surface, and a horizontal plane six (6) inches above the crest of the pipe; and the horizontal dimension shall be determined by the distance between vertical planes, equal to the span of the pipe plus two times the rise but not in excess of the horizontal diameter plus ten (10) feet.

For reinforced box culverts:

The volume to be measured shall not exceed the vertical dimension bounded by the original ground surface and a horizontal plane flush with the top of the structure; and the horizontal dimension shall be determined by the distance between vertical planes outside the walls of the structure, equal to the outside width plus two times the external height of the structure, but not in excess of the outside width plus ten (10) feet.

The volume of the structure contained shall be deducted from the volume of backfill. Backfill above the top limits of structure excavation for headwalls for pipe culverts thirty-six (36) inches or less in diameter shall not be measured or paid for directly.

22.7 Basis of Payment. When an item for backfill does not appear in the proposal, backfill shall be considered as incidental to the installation of the structure and compensation shall be included in the contract prices for other items of the work.

When the proposal includes such an item, the quantity, measured as provided above, shall be paid for at the contract unit price bid per cubic yard for "Backfill", which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work. Payment specified above shall not include compensation for roadway excavation, borrow or selected borrow used for backfill. The quantities of these items required shall be paid for as specified for the particular material used, except that when there is no proposal item for borrow or selected borrow, the quantity required shall be measured and paid for as roadway excavation. Compacting backfill with mechanical tamping units shall be considered as subsidiary work and all costs and expense in connection therewith shall be considered as included in this item of work and no additional compensation will be allowed.

Water applied as directed by the engineer shall be measured and paid for as specified in Section 28, "Watering".

Rolling as directed by the engineer shall be measured and paid for in accordance with Section 29 "Rolling".

SECTION 23 - FOUNDATION FILL

23.1 Description. This item shall consist of furnishing and placing sand, gravel, rock or any suitable combination of these materials in areas where unstable foundation materials have been excavated below the foundation elevation for culverts, bridges and all other structures in accordance with these specifications and in conformity with the grades and elevations shown on the plans or ordered by the engineer.

23.2 Material. The material shall be suitably graded sand, gravel, crushed rock or combination thereof.

23.3 Construction Methods. After unsatisfactory material has been removed to the depth required by the engineer, or otherwise directed, and piles driven if called for, the material so excavated shall be replaced with a suitably graded sand, gravel, crushed rock, or combinations thereof, as designated by the engineer, to bring the sub-foundation to the elevation shown or set by the engineer. All of this material shall be compacted in layers not exceeding four (4) inches in thickness (loose measurement) by the use of mechanical tampers, hand tamping or other approved methods. Water shall be added if necessary to bring the material to the ultimate moisture content for maximum consolidation.

23.4 Method of Measurement and Basis of Payment. "Foundation Fill" will be measured in cubic yards of volume in place, and the quantity to be paid for shall be the same as the quantity of excavation allowed below the elevation of the bottom of footing or structure. The material so measured shall be paid for at the contract unit price bid per cubic yard for "Foundation Fill", which payment shall be full compensation for producing, hauling, depositing, and compacting the material placed and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

When an item for "Foundation Fill" does not appear in the proposal and the need for furnishing and placing of foundation fill material is determined to be necessary during construction by the engineer, the cost thereof will be paid for as extra work, as provided under Articles 4.5 and ~~9.5~~ 9.4 of these specifications.

Water, used as directed to assist in compaction, shall be measured and paid for as specified in Section 28, "Watering".

SECTION 24
(BLANK)

SECTION 25
(BLANK)

SECTION 26 - RESHAPING ROADWAY

26.1 Description. This item shall consist of the restoration and preparation of the roadway where the grading work and placing of mineral aggregate courses or the grading work alone for the construction of the roadway has been substantially completed under previous separate contracts and if such item appears as a bid item in the proposal.

This work shall include all excavation and embankment necessary to restore or prepare the previously graded roadbed to the required grade, line, and section, to receive an initial base or surface course or additional base and surfacing. It shall also include finishing, trimming, and dressing of the shoulder to ditch slopes, embankment slopes, cut slopes, and also all other portions of the roadway disturbed by the elements or the operation of the contractor.

26.2 Construction Methods. All slides shall be removed and the roadway ditches shall be cut to the lines and grades shown on the plans. Material removed from slides or ditches shall be used to widen uniformly or build-up low places in the embankment or be disposed of otherwise as ordered by the engineer. When the roadway is to receive additional base or surfacing, the entire roadbed area shall be shaped smooth and compacted. The slopes and ditches shall be brought to the grade line as established on the plans or as staked by the engineer, by necessary scarifying, plowing, moving, and shaping of the earth to accomplish the desired section.

When the roadway is to receive initial surfacing, the roadway shall be reconstructed to the lines and grades shown on the plans, and any material required in addition to that obtained from slides, ditches, and smoothing of the roadway shall be obtained and placed in accordance with the specifications for the material used, as indicated on the plans or directed by the engineer.

Shaping and compacting will be with proper equipment, supplemented with hand methods if necessary.

All material shall be brought to the proper moisture content and compacted in accordance with the requirements set forth in these specifications. Grading of the surface shall be continuous during the rolling operations in order to form a well-shaped roadbed with the required cross section and crown. All loose rock and hard lumps of earth having any dimension greater than two and one-half (2-1/2) inches shall be picked up and disposed of.

26.3 Method of Measurement. Reshaping roadway shall be measured in miles on the centerline of the roadway.

26.4 Basis of Payment. This work shall be paid for at the contract unit price bid per mile for "Reshape Roadway", which price shall be full compensation for removing slides, clearing ditches, disposal of material taken from slides and ditches, trimming slopes for required embankment material, and for all labor, tools, equipment, and incidentals necessary to complete the work described herein.

The application of water, if ordered to assist in compaction, will be measured and paid for as provided in Section 28, "Watering".

Rolling will be measured and paid for as provided in Section 29, "Rolling".

SECTION 27 - ROADSIDE CLEANUP

27.1 Description. This item shall consist of the necessary cleaning, trimming and dressing on those portions of the roadway outside of the finished shoulder line, or outside the outeredges of curb, or curb and gutter where such structures are required. It shall include the removal and disposal of rocks and boulders, logs, dead brush, rubbish, and other objectionable matter; obliteration of old roads to be abandoned; reshaping of old borrow or material pits; and selective clearing and trimming of trees and vegetation; all as shown on the plans or as directed by the engineer. It shall not include any cleanup or other work made necessary by the contractor's operations as described in Article 4.7 bf these specifications.

27.2 Construction Methods. On that portion of the roadway outside the finished shoulder lines, curb or curb and gutter lines, weeds, rocks, boulders, logs, dead brush, rubbish, and other objectionable matter shall be removed. All irregularities shall be made smooth, washed out areas shall be filled and all floors, roadways, railings, bottom chord shoes, and seats of all bridges shall be cleaned of all rubbish, sand, gravel, stone, and dirt and waterways left unobstructed. Culverts and drainage structures shall be left clean for their entire length. All logs, dead brush, rubbish, and other objectionable matter removed from the highway shall be disposed of as provided for under Section 12 "Clearing and Grubbing".

Rocks and boulders shall be removed and disposed of as specified in Section 20 "Embankments".

Old borrow or material pits shall be shaped, trimmed, and sloped to blend with the natural terrain, and so that the natural growth of vegetation will be promoted.

All holes resulting from the removal of stumps or rocks and boulders shall be filled with earth.

All live trees, shrubs, and other plants not designated on the plans or by the engineer to be removed shall be carefully protected.

27.3 Method of Measurement and Basis of Payment. When the proposal does not contain an item for Roadside Cleanup as above specified, and unless otherwise provided in the special provisions, full compensation for any necessary roadside cleanup required to complete construction operations specified shall be considered as included in the contract unit price paid for Roadway Excavation and no additional compensation will be allowed therefor. When such an item is included in the proposal, roadside cleanup shall be paid for on a force account basis, in accordance with Articles 4.5 and 9.5.

SECTION 28 - WATERING

28.1 Description. Watering shall consist of furnishing, hauling and applying all water required for proper compaction of embankment foundation areas, embankments, subgrade, mineral aggregate base and surfacing materials, structure backfill, processing cement treated base or subgrade materials, and for laying dust caused by grading operations and traffic.

It does not include water required for camp uses, mixing or curing Portland cement concrete, water incorporated at the plant in plantmix products, or for other uses not specifically required to be paid for under these specifications.

28.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Water . . . . . .Section 80

28.3 Equipment. Equipment used for applying water required for compacting embankment materials, subgrade, base and surfacing materials and for laying dust shall be pressure type distributors equipped with a spray system that will insure uniform application of water. The water shall be distributed from the tanks under a minimum pressure of ten (10) pounds per square inch. The distributors shall be mounted on pneumatic-tired trucks or pneumatic-tired equipment. The contractor shall provide satisfactory means for calibration of the tanks and rates of application. The distributor equipment shall be constructed to permit accurate and uniform distribution of the desired quantity of water per unit of surface area. All the watering equipment used for the application of water shall be equipped with a positive means of shut-off and the use of equipment not so equipped will not be permitted.

When permitted in writing, an approved pump, pipe, hoze and nozzle equipment provided with an adequate metering device may be used in embankment construction. Where the head is sufficient to provide equal pressure, the pump requirement may be eliminated.

28.4 Construction Methods. Water shall be applied in the amounts and on the areas designated by the engineer and in such manner as to insure uniform application.

Excavation areas and borrow pits may be watered, prior to excavating material. Only that quantity of water required for compaction of the material on the roadbed will be paid for.

After the water has been applied, the material shall be processed by suitable equipment until the layer is uniformly wet. Care shall be taken to avoid disturbing layers which have been previously placed and compacted. When directed by the engineer, watering shall be done at night or in the early morning hours when evaporation loss is at a minimum.

The contractor shall make all arrangements for providing an adequate water supply. He shall negotiate with owners of supply and sign an agreement

with each owner prior to removing the water. He shall pay all royalties occuring under such agreements and shall also obtain any necessary right-of-way and construct haul roads.

28.5 Method of Measurement. When the proposal contains an item of "Furnish Water Equipment", it shall include the developing of an adequate water supply, the furnishing of all necessary equipment for obtaining water from the source or sources and the furnishing on the job of equipment necessary to apply the water in quantities as directed by the engineer and shall be measured for payment as a unit.

The quantity of water actually applied as directed by the engineer shall be measured in the sprinkler tanks of predetermined capacity at point of delivery or by the means of meters of a type approved by the engineer, which shall be furnished and installed at the expense of the contractor, in units of one thousand (1000) U.S. gallons.

28.6 Basis of Payment. When an item is included in the proposal, the furnishing of an adequate water supply, equipment for obtaining water from the sources and for furnishing applying equipment on the job shall be paid for at the contract lump sum price for "Furnish Water Equipment", which payment shall include full compensation for furnishing all labor, materials, tools, supplies and equipment, and doing all the work necessary to develop a sufficient supply of water and to furnish the necessary equipment for supplying the water to the spreading equipment as specified. Unless an item is included in the proposal or it is otherwise provided for in the special provisions, the contract unit price for "Water" shall be considered as including payment for furnishing all water equipment.

The quantity of water acceptably applied as directed by the engineer, measured as provided above, shall be paid for at the contract unit price bid per one thousand gallons (M gal) for "Water", which payment shall be full compensation for furnishing all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work.

The department reserves the right to increase or omit all or any part of the estimated amount of water to be used and no additional compensation shall be allowed by reason of such increase or decrease.

SECTION 29 - ROLLING

29.1 Description. Rolling shall consist of furnishing and operating rolling equipment for the compaction of foundation for embankment, embankments, subgrade, gravel base courses, soil-cement base courses, and gravel or crushed rock surface courses, but does not include furnishing and operating equipment for the compaction of bituminous base or surface courses.

29.2 Equipment. The rolling equipment used in the performance of the work shall be capable of consistently obtaining the specified compaction, shall conform to the requirements hereinafter prescribed and shall be of the type set forth in applicable sections of these specifications.

All rollers shall be in first-class mechanical condition, adequately equipped and powered and shall be subject to the approval of the engineer as to type, size and mechanical condition. No roller shall be permitted on any project that does not have displayed thereon in permanent legible characters, the manufacturer's guaranteed weight without ballast. The rollers shall be continuously maintained in first-class operating condition throughout their use on the project. Whenever rollers are found unsatisfactory by the engineer they will be changed, replaced, or removed from the work as required by the engineer.

The rolling equipment used in the work performed under applicable sections of the specifications shall comply with the following requirements:

(a) Tandem Rollers. Rollers of this type shall be of sturdy construction, have a low center of gravity, and be perfectly balanced on the longitudinal axis. These rollers shall have smooth operating reversing clutches and smooth operating brakes of ample capacity.

The rims of the driving and guide roll shall be machined to a true surface.

All rollers shall be equipped with sprinkling systems having storage tanks of not less than seventy (70) gallons total capacity. The water shall be piped to front and rear rolls. The spray pipe shall extend the full width of roll and shall be so installed as to be readily cleanable. The water shall be distributed from the spray pipes through fiber mats securely suspended against rolls. Adjustable spring scrapers shall be fitted to front and rear rolls to scrape in both directions.

The distribution of weight shall be such that not more than sixty-eight (68) percent of the total gross weight be placed upon the driving roll.

Min. diameter, driving roll, inches	52
Min. diameter, guide roll, inches	40
Min. rolling width, inches	50
Min. compression, per inch width driving roll, pounds	184
Max. rolling speed M.P.H.	2.0
Min. wheel base, inches	120

(b) Three-Wheeled Rollers. Rollers of this type shall be of rigid and sturdy construction.

The rims of front and rear wheels shall be made of gray iron, semi-steel or other alloys of extreme density and toughness. The rolls shall be machined with a smooth surface.

Gasoline or diesel propelled rollers shall have smooth operating friction clutches or torque converters of the reversing type and smooth operating brakes of ample capacity.

All rollers of this type shall be equipped with sprinkling systems as hereinbefore prescribed for tandem rollers and placed in such manner that not more than seventy-five (75) percent of the combined weight of tank and contents shall be distributed to the rear axle.

Front and rear rolls shall have closely fitting spring scrapers adjustable for forward and reverse motion.

The minimum compression required per inch width of rear wheels is based on the net operating weight of the roller.

The distribution of weight shall be such that not more than seventy-two (72) percent of the total gross weight be carried on the rear axle.

Three wheeled rollers shall weigh not less than ten (10) tons new operating weight and shall conform to the following:

Min. diameter, drive rolls, inches	68
Min. width, drive rolls, inches	24
Min. compression per inch, of width drive rolls, pounds	300
Min. diameter, guide roll, inches	40
Min. laps, each side guide and drive rolls, inches	4
Max, width, outside drive roll to outside drive roll, inches	85
Max. rolling speed, M.P.H.	1.5
Min. wheel base, inches	126

(c) Tamping (Sheepsfoot) Rollers. Rollers of this type shall consist of watertight steel drum mounted in a rigid frame. The outer surface of the drum shall be studded with rows of tamping feet firmly fused to the drum exterior. Frames on all units shall be mounted to give full oscillation and uniform ground pressure. Cleaner teeth shall be mounted on all units in such a manner that they will constantly clean the working feet of earth accumulation. The tamper feet shall be maintained to manufactured shape and dimension by replacement of feet or building up by welding.

The roller unit shall be so designed that the weight may be increased to not less than two hundred-fifty (250) pounds per square inch of bearing surface on the tamping feet in contact with the ground. The load on the tamper feet shall be determined by dividing the total weight of the roller unit by the area in square inches of surface of the tamper feet in contact with the ground. The engineer shall determine the operating weight suited to the nature of soil being compacted and the rollers shall be operated at that weight.

The right is reserved to remove any tamping roller unit from the work, if in the sole opinion of the engineer, the unit is not compacting the earth properly due to nature of the soils or mechanical deficiencies.

A tamping roller unit shall consist of two metal rollers in rigid frames mounted as a unit in such manner that each drum may oscillate independent of the other, and in addition to the foregoing requirements shall conform to the following:

Min. outside diameter of roller without feet, inches	40
Min. length of each roller drum, inches	48
Min. number of tamping feet per drum	88
Min. tamping area of each foot, sq. in	5.4
Min. number of feet on ground	4
Min. length of foot, inches	7
Min. weight empty, pounds	5,700
Min. contact pressure, p.s.i	105

Each tamping roller unit shall be drawn by means of a suitable tractor having sufficient weight to provide all necessary traction and sufficient power under actual working conditions to pull or push the unit at a minimum speed of three (3) miles per hour.

(d) Pneumatic-Tired Roller. Pneumatic-tired rollers shall consist of not less than nine (9) wheels equipped with pneumatic-tires of equal size and diameter mounted on two axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading; so that the total weight of the roller can be varied to produce an operating weight per tire of between one thousand (1000) and two thousand (2000) pounds. The tires shall have treads satisfactory to the engineer. The tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by one tread of the following tires. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than five (5) pounds per square inch.

The pneumatic-tired roller shall be drawn by a suitable type tractor or truck of adequate tractive power to pull the roller at not less than three (3) miles per hour or may be self-propelled. The roller together with its motive power shall be considered a pneumatic-tired roller unit and in addition to the above requirements shall conform to the following:

Min. rolling width, inches	60
Operating weight per tire, pounds	285-2000
Min. tire size, inches	7.50 x 15 (4 ply)
Inflation pressure, p.s.i	Tire Mfg. Recommendations
Range of ground pressure, pounds per in. roller width	43 - 300

The right is reserved to remove any pneumatic-tired roller from the work, if, in the sole opinion of the engineer, the unit is not compacting the earth properly due to the nature of the soils or mechanical deficiencies.

29.3 Method of Measurement and Basis of Payment. Self-propelled smooth-wheeled power rollers, described herein, used for compaction of materials as herein set forth, shall be paid for at the contract unit price per hour for "Power Roller", which price shall be full compensation for the smooth-wheeled power roller, operator, fuel, lubricants, and for all labor, materials, tools, supplies, equipment, and incidentals necessary for satisfactory operation.

For the purpose of payment the unit of measurement for tamping and pneumatic-tired roller shall be a foot-hour. A foot-hour shall be considered as a

net length of one (1) linear foot of double-axle roller or tamping drum, measured along its axis, between the outer face of the tires or the drum, used for compaction of materials as herein set forth for one (1) hour.

The total number of double-axle rollers or tamping rollers used as directed by the engineer shall be paid for per foot-hour.

The foot-hours of tamping roller or pneumatic-tired roller, as measured above, shall be paid for at the contract unit price bid per foot-hour for "Tamping Roller", "Pneumatic-tired Roller" or "Tamping or Pneumatic-tired Roller", as indicated in the proposal, which payment shall include motive power for its propulsion, operator, fuel, lubricants, and for all labor, materials, tools, supplies, equipment, and incidentals necessary for satisfactory operation.

The department reserves the right to increase, or to omit all or any part of the estimated amount of rolling, and no additional compensation shall be allowed by reason of such increase or decrease.

SECTION 30 - GRAVEL BASE COURSES

30.1 Description. Gravel base courses shall consist of furnishing and placing on the completed and accepted subgrade, selected granular material, screened gravel and/or crushed gravel, or crushed stone, in conformity with the line, grades, dimensions and typical cross-section shown on the plans and as hereinafter specified and as ordered by the engineer.

30.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Selected Material	Section 81
Aggregate for Type 1 Gravel Base (3 sizes, choice of size optional unless otherwise specified)	Section 82
Aggregate for Type 2 Gravel Base (2 sizes, choice of size optional unless otherwise specified)	Section 82

30.3 Placing. The base material shall be uniformly spread on the approved subgrade by means of the hauling vehicle with or without spreading devices, and shall be distributed over the surface to the depth hereinafter specified or as directed. Spreading shall be done in such manner as to prevent segregation of the different sizes of material and any such segregation, unless satisfactorily corrected, shall be cause for rejection at the discretion of the engineer. Any material thus rejected shall be removed from the base and shall be disposed of as directed.

In placing a pit run base, larger sized particles of the maximum diameter equal to the compacted thickness of the layer being placed may be incorporated into that layer. Those pieces of oversize too large to be placed in the layer shall be bladed to the side of the road and disposed of in a manner satisfactory to the engineer.

Where the required thickness is six (6) inches or less the base materials may be spread and compacted in one layer. Where the required thickness is more than six (6) inches the base material shall be spread and compacted in two or more layers of approximately equal thickness, the maximum compacted thickness of any one layer shall not exceed six (6) inches, and each layer shall be spread and compacted in a similar manner.

Depositing shall commence at that part of the work farthest from the point of loading the material and shall progress continuously without breaks, unless otherwise directed by the engineer.

After base course material has been spread, it shall be thoroughly blade-mixed to full depth of the layer by alternately blading the entire layer to the center and back to the edges of the road. During this processing, water shall be applied as directed. It shall then be respread and finished to the required cross-section by means of a self-propelled pneumatic-tired motor grader having a wheel base of not less than fifteen (15) feet and a blade of not less than ten (10) feet long.

30.4 Wetting and Compaction. Water shall be applied immediately prior to and during all blading and processing operations, in amounts directed by the engineer, to moisten the material sufficiently to prevent segregation of the fine and coarse particles. Water shall be applied during the compaction and maintenance stages in sufficient amounts, as determined by the engineer, to assist in compaction and prevent raveling.

Each layer of gravel base course shall be rolled with a pneumatic-tired roller or a smooth-wheeled power roller of the type prescribed in Section 29. Rolling shall be parallel to the centerline of the road and shall commence at the outside edges of the base material and progress towards the center of the roadbed. Under no circumstances shall the center of the base material be rolled first. The roller shall overlap on successive trips approximately one-half the width of the roller. Rolling shall continue until all the surface has been rolled and the maximum feasible amount of compaction and bond have been obtained or when tested in accordance with the test method in use by the laboratory of the department, the relative compaction of each layer of compacted base material shall not be less than ninety-five (95) percent. Any high spots or low spots that develop shall be corrected by loosening the material in these places and adding or removing material until the surface is smooth and uniform. After the bases have been completely compacted, the top layer of the Type 2 gravel base shall be bladed with a motor patrol and again watered and re-rolled. Watering and rolling shall be performed alternately as required or directed to maintain a smooth, even, uniformly compacted base until a surface course or other treatment that may be provided for in the same contract is placed thereon, or until final acceptance.

Sections along curbs, near structures, and all other places not accessible to the compaction equipment shall be tamped thoroughly with mechanical tampers or with hand tampers that are sufficiently heavy to give good compaction.

Waves, corrugations and ruts shall not be allowed to form and the base shall be bladed as often as necessary, re-watered and recompacted to maintain a true cross-section and grade until the work is accepted or until it is covered with a succeeding course.

30.5 Method of Measurement. The quantity to be paid for, conforming to all the requirements in the completed and accepted work, will be measured either by the ton or cubic yard as indicated in the proposal form. The measurement will be made as set forth in Section 9, Article 9.1 of these specifications.

30.6 Basis of Payment. The quantity of base material measured as provided above shall be paid for at the contract unit price per ton or per cubic yard for "Type 1 Gravel Base", "Type 2 Gravel Base", or "Selected Material Base", as the case may be, which price shall be full compensation for stripping the pit, crushing, screening, loading, hauling, placing, and maintaining the base, and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, except watering ~~and rolling~~ compacting.

Water applied as directed shall be measured and paid for as specified in Section 28.

Rolling ~~as directed by the engineer shall~~ be measured and paid for as specified in Section 29.

SECTION 31
(BLANK)

SECTION 32 - SELECTED MATERIAL SURFACE COURSE

32.1 Description. This item shall consist of a surface course composed of selected granular material constructed on the completed and accepted subgrade or base course in accordance with these specifications and in conformity with the lines, grades, and typical cross-section shown on the plans or ordered by the engineer.

32.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Selected Material	Section 81

32.3 Placing. In producing, handling, and placing selected material care shall be taken to prevent segregation of the fine particles from the coarse. When the required compacted thickness is four (4) inches or more, the material shall be placed in layers, none of which shall exceed four (4) inches in depth before compaction.

The material shall be distributed uniformly either directly from the tail gates of the hauling vehicles or by approved spreader boxes.

After the material has been spread, it shall be thoroughly blade-mixed to the full depth of the layer by alternately blading the entire layer to the center and back to the edges of the roadbed. It shall then be spread and finished to the required cross-section by means of a modern motor patrol grader that will give the desired results as to the uniformity and smoothness.

Each layer shall be finished to lines and grades before starting the succeeding layer.

The selected material shall be placed only when the subgrade or base is in suitable condition to receive the material. Hauling over the subgrade, base or over the surfacing, completed or in the process of construction, will not be permitted when it is detrimental to the subgrade, base or surfacing.

Binder material, if required, shall be incorporated either in the surfacing aggregate at the plant when the aggregate is produced, or shall be corporated uniformly on the roadbed in amounts and as directed by the engineer.

32.4 Watering. Water shall be applied immediately prior to and during all blading operations, to moisten the material sufficiently to prevent segregation of the fine and coarse particles, in amounts deemed necessary by the engineer. Water shall be applied during the compaction and maintenance stages in sufficient amounts to assist in compaction and prevent raveling, as directed.

32.5 Compaction. Each course or layer shall be compacted separately by rolling with a self-propelled power roller weighing at least eight (8) tons or by an approved pneumatic-tired roller conforming to the requirements of Section 29, "Rolling". Rolling shall be parallel to the center line of the roadbed and shall begin at the outer edges, progressing gradually to the center. Wheels shall lap each proceeding track by one-half the width of such track and shall continue until all the surface has been rolled and the maximum feasible amount of compaction and bond has been obtained. Any irregularities

or depressions that develop shall be corrected by loosening the material in these places and adding or removing material until the surface is smooth and uniform. During compaction the surface shall be bladed or floated continuously in order to prevent corrugations or segregations of materials. Water shall be applied as required, to assist in compaction.

Sections along curbs, near structures, and all other places not accessible to the compaction equipment shall be tamped thoroughly with mechanical tampers or with hand tampers that are sufficiently heavy to give good compaction.

32.6 Maintenance. Waves, corrugations and ruts shall not be allowed to form, and the selected material shall be bladed as often as necessary to maintain a true grade cross-section until the work is accepted.

32.7 Method of Measurement. The quantity to be paid for, conforming to all the requirements in the completed and accepted work, will be measured either by the ton or cubic yard as indicated in the proposal form. The measurement will be made as set forth in Section 9, Article 9.1 of these specifications.

32.8 Basis of Payment. The quantity of surfacing material, measured as provided above, shall be paid for at the contract unit price per ton or per cubic yard, for "Selected Material Surface," which price shall be full compensation for stripping of pit, crushing, screening, loading, hauling, and placing material on the roadway; for maintaining the surface; and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, except watering and rolling.

The quantity of water acceptably applied shall be measured and paid for as provided in Section 28.

Rolling shall be measured and paid for as specified in Section 29.

SECTION 33 - APPLICATION OF BITUMINOUS BINDERS

33.1 Description. This specification covers the equipment, methods and method of measurement applicable when bituminous binders are spread on the roadway or are mixed at a central mixing plant as part of the construction of other items of these specifications.

33.2 General. Attention is directed to Sections 34, 35, 36, 37, 38, 39, and 40 of these specifications.

Bituminous binders applied on the roadbed shall be prevented from spraying upon adjacent pavements or that portion of the traveled way being used by traffic and upon structures, guard rails, bridges, culverts, posts, trees and shrubbery that are not to be removed, adjacent property and improvements, and other highway improvements or facilities not mentioned above. During application of bituminous binders, distributors shall stop while traffic is passing, and traffic shall be stopped when distributor is in operation.

The various grades of bituminous binders shall be applied at a temperature within the limits of the application temperature specified hereinafter, unless otherwise specified in these specifications, in the special provisions, or ordered by the engineer.

When liquid asphalt is to be mixed with mineral aggregate at a central mixing plant the temperature of the mineral aggregate, at the time of adding the liquid asphalt shall not exceed that shown in the column "Temperature of Aggregate" appearing in Article 33.5.

After loading materials into a tank car or truck for transportation to the site of the work, the temperature of the bituminous binders shall not be raised above that given as the maximum temperature in Article 33.5 of this specification, unless otherwise authorized by the engineer.

Bituminous binder shall be heated by a retort or a steam coil in such a manner that steam will not be introduced directly into binders during heating. The contractor shall furnish and keep on the work at all times, an accurate thermometer suitable for determining the temperature of the bituminous binder being applied.

The contractor shall provide some method satisfactory to the engineer of accurately measuring the volume of bituminous binders in his storage tanks and in each spreading unit at any time.

Discharging unused bituminous binders within the highway right-of-way will not be permitted.

Bituminous binders delivered to the work shall not be used for any purpose other than that provided for in the specification.

Bituminous binders added to mineral aggregate at a central-mixing plant shall be accurately weighed by means of a springless dial scale with a capacity of not more than five hundred (500) pounds with one pound graduations, or other scales approved by the engineer in the case of batch plants; or the bituminous binder shall be introduced into the mixer through an indicator meter by a posi-

tive displacement type pump in the case of a continuous mixer. Bituminous binders added to mineral aggregate in a travel-mixing plant shall be accurately measured by means of meters or other approved measuring device. Except as otherwise provided under "Method of Measurement" of this section, weighing or measuring bituminous binders being added to mineral aggregate at mixing plants in accordance with the above specified methods shall be for the purpose of properly proportioning the material and not for determining the pay quantities of bituminous binders.

33.3 Equipment. Distributor truck for applying bituminous binders for prime coats, seal coats, surface treatment, or roadmixed surface shall be of approved pressure type with insulated tanks. Gravity distributors will not be permitted. Spray bars shall be of the full circulating type and shall have a minimum length of nine (9) feet. The header bars shall be adjustable to permit varying height above the surface to be treated. The nozzles attached to the bar shall be either of the conical or flat slotted type. When spreading asphaltic emulsion suitable nozzles for the application of the emulsions shall be used. The distance center to center of the nozzles shall not exceed six (6) inches. The valves shall be operated by levers so that one or all valves may be quickly opened or closed in one operation. The spray bars shall be controlled by a bootman riding at the rear of the distributor where the operation of all sprays is in full view. Spreading by means of cab controlled valves will not be permitted. The valves which control the flow from nozzles shall be of positive acting design so as to provide a uniform, unbroken spread of bituminous binders on the surface. Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous binder being applied and with tachometer of the auxiliary wheel type reading in feet per minute. The spreading equipment shall be so designed and articulated that uniform application of bituminous binder, in controlled amounts, may be made ranging from two-hundredths (0.02) to one (1) gallon per square yard of surface and with a range of pressure from twenty-five (25) to seventy-five (75) pounds per square inch. If a spray bar extension is used to cover a greater width, it shall be of the full circulating type. The distributor shall be equipped with a hose and hand nozzle attachment to be used for spotting skipped areas and areas inaccessible to the distributor. The distributor shall also be equipped with pressure gauges and an accurate thermometer for determination of temperature of bituminous material. Distributors and booster tanks shall be so maintained at all times as to prevent dripping of bituminous material from any part of the equipment.

In order to secure uniform distribution at the junction of two applications, the distribution shall be promptly stopped when the uniform flow decreases, indicating the tank is about empty. The cutoffs shall be made on building paper previously spread over the surface to be treated. Building paper shall be spread over the treated surface for a sufficient length back so that the nozzles are spreading properly when the uncovered surface is reached. The building paper shall then be removed and disposed of in a manner satisfactory to the engineer.

The engineer reserves the right to order the use of any equipment discontinued that, in his opinion, fails to produce a satisfactory distribution of bituminous binders in accordance with these specifications.

33.4 Weather Conditions. Application of bituminous binders will not be permitted when the surface to be treated is damp or wet or when weather conditions are unsuitable or when the atmospheric temperature or aggregate temperature is below fifty (50) degrees F.

33.5 Temperature of Application. Asphaltic emulsion shall be heated, if necessary, and applied in accordance with the applicable provisions hereinbefore stated, and the following additional requirements. Asphaltic emulsion shall be applied at a temperature of between one hundred (100) degrees F., and one hundred and fifty (150) degrees F., unless otherwise ordered by the engineer. Under no circumstances shall the emulsion be heated to a temperature greater than one hundred and fifty (150) degrees F., nor exposed to a temperature of less than forty (40) degrees F. The distributor spray bar shall be equipped with asphaltic emulsion type spray jets, and full compensation therefore shall be considered as included in the contract price paid for the emulsion.

Asphalt cements shall be applied at the temperatures prescribed in Section 40 of these specifications.

Various grades of liquid asphalt shall be applied at not less than the minimum temperature specified below nor shall the temperature be raised above that given in the last column of the following table, unless authorized by the engineer.

APPLICATION TEMPERATURES OF LIQUID ASPHALTS

Grade of Liquid Asphalt	Plant Mixing Temperature of Aggregate, Maximum °F.	Distributor Application Temperature Minimum °F.	Distributor Application Temperature Maximum °F.
RC-2	200	150	200
RC-3	225	175	225
RC-4	250	200	250
RC-5	275	225	275
MC-2	200	175	225
MC-3	225	200	250
MC-4	250	225	275
MC-5	275	250	300
SC-2	200	200	250
SC-3	225	225	300
SC-4	250	250	325
SC-5	275	275	350
SC-6	- -	300	400

33.6 Method of Measurement. The unit of measurement for liquid asphalts, asphaltic emulsions, and paving asphalts shall be a ton of two thousand (2000) pounds.

Quantities of bituminous binders wasted or disposed of in a manner not called for under these specifications, or remaining on hand after completion of the work, will not be paid for.

Except as otherwise provided under this article for volume measurement of pay quantities, and unless otherwise set forth in these specifications or in the special provisions, quantities of bituminous binder to be paid for on a weight basis shall be determined in accordance with the following procedure.

Each vehicle used in transporting bituminous binders, other than railroad cars, shall be accompanied by weigh tickets signed by the supplier and/or transporting agency and shall show vehicle license number, gross, tare and net weights, otherwise show volume as loaded, temperature of loading, gallons at sixty (60) degrees F., and net tons. This information in acceptable form will be used as the basis for computing pay quantities.

The department will accept certified railroad weights, or certified weight factors satisfactory to the engineer on all rail shipments of bituminous binders. When railroad car weights are to be accepted as a basis for computing pay quantities, cars shall not be released by the contractor until inspected by the engineer to determine that they are completely empty.

Full compensation for weighing bituminous binders as specified above shall be considered as included in the unit prices paid per ton for the bituminous binder or the prices paid for the items of work involving the use of the bituminous binder and no additional compensation will be made therefor.

When permitted by the engineer, pay quantities of bituminous binder may be determined from volumetric measurements of the bituminous binder, in which case the bituminous binder shall be delivered in calibrated tanks and each tank shall be accompanied by its proper measuring stick and a calibration card signed by a sealer of weights and measures, and pay quantities shall be determined in accordance with the following procedure.

When pay quantities of bituminous binder are determined from volumetric measures as provided above, the volumetric measurements at any temperature shall be reduced to the volume the material would occupy at sixty (60) degrees F., before converting the volumetric measurements to weight.

The following table shall be used to convert volumes from gallons to weight. All types, SC, MC and RC of the same grade shall be considered to have equal weights per volume.

AVERAGE WEIGHTS AND VOLUMES OF LIQUID ASPHALT

Grade	Gallons per Ton at 60° F.	Barrels per ton at 60° F. (42 U.S. Gals.)	Pounds per Gal. at 60° F.
2	248	5.90	8.07
3	245	5.84	8.16
4	243	5.78	8.23
5	241	5.74	8.30
6 (SC only)	239	5.70	8.36

AVERAGE WEIGHTS AND VOLUMES OF ASPHALT CEMENT

Grade	Gallons per Ton at 60° F.	Barrels per ton at 60° F. (42 U.S. Gals.)	Pounds per Gal. at 60° F.
60-70	235	5.60	8.51
85-100	235	5.60	8.51
120-150	237	5.64	8.44
200-300	239	5.70	8.36

AVERAGE WEIGHTS AND VOLUMES OF ASPHALTIC EMULSION

Type of Emulsion	Gallons per Ton at 60° F.	Barrels per ton at 60° F. (42 U.S. Gals.)	Pounds per Gal. at 60° F.
RS-1	240	5.71	8.33
MS-1	240	5.71	8.33
RS-2	240	5.71	8.33

The following conversion tables shall be used to convert the volume at any temperature to the volume at sixty (60) degrees F.

CONVERSION TABLE I

The following table is to be used for converting volumes of liquid asphalt products, grades 2 to 5 inclusive, and paving asphalts, grades 60-70 to 200-300 inclusive.

Legend: t—observed temperature in degrees Fahrenheit
M—multiplier for reducing volumes to the basis of 60° F

t	M	t	M	t	M	t	M	t	M
0	1.0211	50	1.0035	100	0.9861	150	0.9689	200	0.9520
1	1.0208	51	1.0031	101	0.9857	151	0.9686	201	0.9516
2	1.0204	52	1.0028	102	0.9854	152	0.9682	202	0.9513
3	1.0201	53	1.0024	103	0.9851	153	0.9679	203	0.9509
4	1.0197	54	1.0021	104	0.9847	154	0.9675	204	0.9506
5	1.0194	55	1.0017	105	0.9844	155	0.9672	205	0.9503
6	1.0190	56	1.0014	106	0.9840	156	0.9669	206	0.9499
7	1.0186	57	1.0010	107	0.9837	157	0.9665	207	0.9496
8	1.0183	58	1.0007	108	0.9833	158	0.9662	208	0.9493
9	1.0179	59	1.0003	109	0.9830	159	0.9658	209	0.9489
10	1.0176	60	1.0000	110	0.9826	160	0.9655	210	0.9486
11	1.0172	61	0.9997	111	0.9823	161	0.9652	211	0.9483
12	1.0169	62	0.9993	112	0.9819	162	0.9648	212	0.9479
13	1.0165	63	0.9990	113	0.9816	163	0.9645	213	0.9476
14	1.0162	64	0.9986	114	0.9813	164	0.9641	214	0.9472
15	1.0158	65	0.9983	115	0.9809	165	0.9638	215	0.9469
16	1.0155	66	0.9979	116	0.9806	166	0.9635	216	0.9466
17	1.0151	67	0.9976	117	0.9802	167	0.9631	217	0.9462
18	1.0148	68	0.9972	118	0.9799	168	0.9628	218	0.9459
19	1.0144	69	0.9969	119	0.9795	169	0.9624	219	0.9456
20	1.0141	70	0.9965	120	0.9792	170	0.9621	220	0.9452
21	1.0137	71	0.9962	121	0.9788	171	0.9618	221	0.9449
22	1.0133	72	0.9958	122	0.9785	172	0.9614	222	0.9446
23	1.0130	73	0.9955	123	0.9782	173	0.9611	223	0.9442
24	1.0126	74	0.9951	124	0.9778	174	0.9607	224	0.9439
25	1.0123	75	0.9948	125	0.9775	175	0.9604	225	0.9436
26	1.0119	76	0.9944	126	0.9771	176	0.9601	226	0.9432
27	1.0116	77	0.9941	127	0.9768	177	0.9597	227	0.9429
28	1.0112	78	0.9937	128	0.9764	178	0.9594	228	0.9426
29	1.0109	79	0.9934	129	0.9761	179	0.9590	229	0.9422
30	1.0105	80	0.9930	130	0.9758	180	0.9587	230	0.9419
31	1.0102	81	0.9927	131	0.9754	181	0.9584	231	0.9416
32	1.0098	82	0.9923	132	0.9751	182	0.9580	232	0.9412
33	1.0095	83	0.9920	133	0.9747	183	0.9577	233	0.9409
34	1.0091	84	0.9916	134	0.9744	184	0.9574	234	0.9405
35	1.0088	85	0.9913	135	0.9740	185	0.9570	235	0.9402
36	1.0084	86	0.9909	136	0.9737	186	0.9567	236	0.9399
37	1.0081	87	0.9906	137	0.9734	187	0.9563	237	0.9395
38	1.0077	88	0.9902	138	0.9730	188	0.9560	238	0.9392
39	1.0074	89	0.9899	139	0.9727	189	0.9557	239	0.9389
40	1.0070	90	0.9896	140	0.9723	190	0.9553	240	0.9385
41	1.0067	91	0.9892	141	0.9720	191	0.9550	241	0.9382
42	1.0063	92	0.9889	142	0.9716	192	0.9547	242	0.9379
43	1.0060	93	0.9885	143	0.9713	193	0.9543	243	0.9375
44	1.0056	94	0.9882	144	0.9710	194	0.9540	244	0.9372
45	1.0053	95	0.9878	145	0.9706	195	0.9536	245	0.9369
46	1.0049	96	0.9875	146	0.9703	196	0.9533	246	0.9365
47	1.0046	97	0.9871	147	0.9699	197	0.9530	247	0.9362
48	1.0042	98	0.9868	148	0.9696	198	0.9526	248	0.9359
49	1.0038	99	0.9864	149	0.9693	199	0.9523	249	0.9356

CONVERSION TABLE I—Continued

t	M	t	M	t	M	t	M	t	M
250	0.9352	300	0.9187	350	0.9024	400	0.8864	450	0.8705
251	0.9349	301	0.9184	351	0.9021	401	0.8861	451	0.8702
252	0.9346	302	0.9181	352	0.9018	402	0.8857	452	0.8699
253	0.9342	303	0.9177	353	0.9015	403	0.8854	453	0.8696
254	0.9339	304	0.9174	354	0.9011	404	0.8851	454	0.8693
255	0.9336	305	0.9171	355	0.9008	405	0.8848	455	0.8690
256	0.9332	306	0.9167	356	0.9005	406	0.8845	456	0.8687
257	0.9329	307	0.9164	357	0.9002	407	0.8841	457	0.8683
258	0.9326	308	0.9161	358	0.8998	408	0.8838	458	0.8680
259	0.9322	309	0.9158	359	0.8995	409	0.8835	459	0.8677
260	0.9319	310	0.9154	360	0.8992	410	0.8832	460	0.8674
261	0.9316	311	0.9151	361	0.8989	411	0.8829	461	0.8671
262	0.9312	312	0.9148	362	0.8986	412	0.8826	462	0.8668
263	0.9309	313	0.9145	363	0.8982	413	0.8822	463	0.8665
264	0.9306	314	0.9141	364	0.8979	414	0.8819	464	0.8661
265	0.9302	315	0.9138	365	0.8976	415	0.8816	465	0.8658
266	0.9299	316	0.9135	366	0.8973	416	0.8813	466	0.8655
267	0.9296	317	0.9132	367	0.8969	417	0.8810	467	0.8652
268	0.9293	318	0.9128	368	0.8966	418	0.8806	468	0.8649
269	0.9289	319	0.9125	369	0.8963	419	0.8803	469	0.8646
270	0.9286	320	0.9122	370	0.8960	420	0.8800	470	0.8643
271	0.9283	321	0.9118	371	0.8957	421	0.8797	471	0.8640
272	0.9279	322	0.9115	372	0.8953	422	0.8794	472	0.8636
273	0.9276	323	0.9112	373	0.8950	423	0.8791	473	0.8633
274	0.9273	324	0.9109	374	0.8947	424	0.8787	474	0.8630
275	0.9269	325	0.9105	375	0.8944	425	0.8784	475	0.8627
276	0.9266	326	0.9102	376	0.8941	426	0.8781	476	0.8624
277	0.9263	327	0.9099	377	0.8937	427	0.8778	477	0.8621
278	0.9259	328	0.9096	378	0.8934	428	0.8775	478	0.8618
279	0.9256	329	0.9092	379	0.8931	429	0.8772	479	0.8615
280	0.9253	330	0.9089	380	0.8928	430	0.8768	480	0.8611
281	0.9250	331	0.9086	381	0.8924	431	0.8765	481	0.8608
282	0.9246	332	0.9083	382	0.8921	432	0.8762	482	0.8605
283	0.9243	333	0.9079	383	0.8918	433	0.8759	483	0.8602
284	0.9240	334	0.9076	384	0.8915	434	0.8756	484	0.8599
285	0.9236	335	0.9073	385	0.8912	435	0.8753	485	0.8596
286	0.9233	336	0.9070	386	0.8908	436	0.8749	486	0.8593
287	0.9230	337	0.9066	387	0.8905	437	0.8746	487	0.8590
288	0.9227	338	0.9063	388	0.8902	438	0.8743	488	0.8587
289	0.9223	339	0.9060	389	0.8899	439	0.8740	489	0.8583
290	0.9220	340	0.9057	390	0.8896	440	0.8737	490	0.8580
291	0.9217	341	0.9053	391	0.8892	441	0.8734	491	0.8577
292	0.9213	342	0.9050	392	0.8889	442	0.8731	492	0.8574
293	0.9210	343	0.9047	393	0.8886	443	0.8727	493	0.8571
294	0.9207	344	0.9044	394	0.8883	444	0.8724	494	0.8568
295	0.9204	345	0.9040	395	0.8880	445	0.8721	495	0.8565
296	0.9200	346	0.9037	396	0.8876	446	0.8718	496	0.8562
297	0.9197	347	0.9034	397	0.8873	447	0.8715	497	0.8559
298	0.9194	348	0.9031	398	0.8870	448	0.8712	498	0.8556
299	0.9190	349	0.9028	399	0.8867	449	0.8709	499	0.8552

CONVERSION TABLE II

The following table is to be used for converting volumes of liquid asphalt product, grade 1.

Legend: t—observed temperature in degrees Fahrenheit
M—multiplier for reducing volumes to the basis of 60° F

t	M	t	M	t	M	t	M	t	M
0	1.0241	50	1.0040	100	0.9842	150	0.9647	200	0.9456
1	1.0237	51	1.0036	101	0.9838	151	0.9643	201	0.9452
2	1.0233	52	1.0032	102	0.9834	152	0.9639	202	0.9448
3	1.0229	53	1.0028	103	0.9830	153	0.9635	203	0.9444
4	1.0225	54	1.0024	104	0.9826	154	0.9632	204	0.9441
5	1.0221	55	1.0020	105	0.9822	155	0.9628	205	0.9437
6	1.0217	56	1.0016	106	0.9818	156	0.9624	206	0.9433
7	1.0213	57	1.0012	107	0.9814	157	0.9620	207	0.9429
8	1.0209	58	1.0008	108	0.9810	158	0.9616	208	0.9425
9	1.0205	59	1.0004	109	0.9806	159	0.9612	209	0.9422
10	1.0201	60	1.0000	110	0.9803	160	0.9609	210	0.9418
11	1.0197	61	0.9996	111	0.9799	161	0.9605	211	0.9414
12	1.0193	62	0.9992	112	0.9795	162	0.9601	212	0.9410
13	1.0189	63	0.9988	113	0.9791	163	0.9597	213	0.9407
14	1.0185	64	0.9984	114	0.9787	164	0.9593	214	0.9403
15	1.0181	65	0.9980	115	0.9783	165	0.9589	215	0.9399
16	1.0177	66	0.9976	116	0.9779	166	0.9585	216	0.9395
17	1.0173	67	0.9972	117	0.9775	167	0.9582	217	0.9391
18	1.0168	68	0.9968	118	0.9771	168	0.9578	218	0.9388
19	1.0164	69	0.9964	119	0.9767	169	0.9574	219	0.9384
20	1.0160	70	0.9960	120	0.9763	170	0.9570	220	0.9380
21	1.0156	71	0.9956	121	0.9760	171	0.9566	221	0.9376
22	1.0152	72	0.9952	122	0.9756	172	0.9562	222	0.9373
23	1.0148	73	0.9948	123	0.9752	173	0.9559	223	0.9369
24	1.0144	74	0.9944	124	0.9748	174	0.9555	224	0.9365
25	1.0140	75	0.9940	125	0.9744	175	0.9551	225	0.9361
26	1.0136	76	0.9936	126	0.9740	176	0.9547	226	0.9358
27	1.0132	77	0.9932	127	0.9736	177	0.9543	227	0.9354
28	1.0128	78	0.9929	128	0.9732	178	0.9539	228	0.9350
29	1.0124	79	0.9925	129	0.9728	179	0.9536	229	0.9346
30	1.0120	80	0.9921	130	0.9725	180	0.9532	230	0.9343
31	1.0116	81	0.9917	131	0.9721	181	0.9528	231	0.9339
32	1.0112	82	0.9913	132	0.9717	182	0.9524	232	0.9335
33	1.0108	83	0.9909	133	0.9713	183	0.9520	233	0.9331
34	1.0104	84	0.9905	134	0.9709	184	0.9517	234	0.9328
35	1.0100	85	0.9901	135	0.9705	185	0.9513	235	0.9324
36	1.0096	86	0.9897	136	0.9701	186	0.9509	236	0.9320
37	1.0092	87	0.9893	137	0.9697	187	0.9505	237	0.9316
38	1.0088	88	0.9889	138	0.9693	188	0.9501	238	0.9313
39	1.0084	89	0.9885	139	0.9690	189	0.9498	239	0.9309
40	1.0080	90	0.9881	140	0.9686	190	0.9494	240	0.9305
41	1.0076	91	0.9877	141	0.9682	191	0.9490	241	0.9301
42	1.0072	92	0.9873	142	0.9678	192	0.9486	242	0.9298
43	1.0068	93	0.9869	143	0.9674	193	0.9482	243	0.9294
44	1.0064	94	0.9865	144	0.9670	194	0.9478	244	0.9290
45	1.0060	95	0.9861	145	0.9666	195	0.9475	245	0.9286
46	1.0056	96	0.9857	146	0.9662	196	0.9471	246	0.9283
47	1.0052	97	0.9854	147	0.9659	197	0.9467	247	0.9279
48	1.0048	98	0.9850	148	0.9655	198	0.9463	248	0.9275
49	1.0044	99	0.9846	149	0.9651	199	0.9460	249	0.9272

CONVERSION TABLE III

The following table is to be used for converting volumes of all types of asphaltic emulsion specified in this section.

Legend: t—observed temperature in degrees Fahrenheit
M—multiplier for reducing volumes to the basis of 60° F

t	M	t	M	t	M
60	1.00000	90	.99250	121	.98475
61	.99975	91	.99225	122	.98450
62	.99950	92	.99200	123	.98425
63	.99925	93	.99175	124	.98400
64	.99900	94	.99150	125	.98375
65	.99875	95	.99125	126	.98350
66	.99850	96	.99100	127	.98325
67	.99825	97	.99075	128	.98300
68	.99800	98	.99050	129	.98275
69	.99775	99	.99025	130	.98250
70	.99750	100	.99000	131	.98225
71	.99725	101	.98975	132	.98200
72	.99700	102	.98950	133	.98175
73	.99675	103	.98925	134	.98150
74	.99650	104	.98900	135	.98125
75	.99625	105	.98875	136	.98100
76	.99600	106	.98850	137	.98075
77	.99575	107	.98825	138	.98050
78	.99550	108	.98800	139	.98025
79	.99525	109	.98775	140	.98000
80	.99500	110	.98750	141	.97975
81	.99475	111	.98725	142	.97950
82	.99450	112	.98700	143	.97925
83	.99425	113	.98675	144	.97900
84	.99400	114	.98650	145	.97875
85	.99375	115	.98625	146	.97850
86	.99350	116	.98600	147	.97825
87	.99325	117	.98575	148	.97800
88	.99300	118	.98550	149	.97775
89	.99275	119	.98525	150	.97750
		120	.98500		

SECTION 34 - PRIME COAT

34.1 Description. This item shall consist of the application of a bituminous material on a previously prepared base, subgrade, existing surface or to the first lift or course as a tack coat in advance of spreading the next course when constructing plantmixed surface in more than one course, and if ordered by the engineer, covering the application with sand blotter.

34.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Sand Blotter	Section 89
Liquid Asphalt	Section 91
Emulsified Asphalt	Section 92

Liquid asphalt used as prime coat on a previously prepared base or subgrade shall be of the type shown in the Estimate of Quantities, and the Proposal and shall be applied in accordance with the provisions of Section 33 and as hereinafter specified. The exact rate of application to be determined by the engineer.

Asphaltic emulsion used as a "Tack Coat" between the courses of plantmix surface or over an existing surface shall be of the mixing type and of the grade shown on the Estimate of Quantities and in the Proposal, and prepared for application as follows:

The emulsion, as delivered, shall be cut back with forty (40) percent water, by volume, and thoroughly mixed. To accomplish this mixing, the distributor shall be partly filled with water, and the correct proportion of emulsified asphalt shall then be added, and the remaining water to be added shall be sprayed into the tank under pressure and then thoroughly circulated within the distributor. The diluted emulsified asphalt shall be applied in accordance with the provisions of Section 33 and as hereinafter specified. The exact rate of application shall be as determined by the engineer.

34.3 Construction Methods. Immediately before applying a prime coat the area to be surfaced shall be cleaned of all loose material by means of power brooms, supplemented by hand brooming if necessary. The surface to be primed shall be thoroughly bonded and compacted, true to grade and cross-section, and free from ruts, bumps and other irregularities.

The bituminous material used for prime coat shall be uniformly heated and applied by means of equipment conforming to the requirements of Section 33. The temperature of the bituminous material at the time of application shall be not less than specified in Section 33, the exact temperature to be determined by the engineer.

The prime coat shall be allowed to penetrate and cure for a period of not less than twenty-four (24) hours. This period may be shortened by the engineer, if the nature of the base being primed and favorable conditions of weather result in proper curing before the stipulated time has elapsed.

When so ordered by the engineer, after the bituminous material has penetrated the surface, the treated area shall be covered, where necessary, with sand

blotter to prevent pick up under traffic, but generally traffic shall be kept off the prime until it is sufficiently cured to accommodate it.

When the plantmix surface is spread and compacted in more than one liff or course or is placed on a previously prepared bituminous surface or base, or concrete base or surface, a dilute emulsified asphalt tack coat shall be applied at a uniform rate of from five-hundredths (0.05) to fifteen-hundredths (0.15) gallons per square yard as ordered. The dilute emulsified asphalt shall be prepared and applied as prescribed above.

Suitable precautions shall be taken for the protection of the prime and tack coats against any damage during its curing period and until the surface course is in place.

If the road is not to be closed to traffic during construction operation, the work shall be handled so as to cause the least possible inconvenience to traffic and the traffic safely maintained in accordance with the requirements of Section 11 and as ordered by the engineer.

No bituminous material shall be applied when the atmospheric temperature is below fifty (50) degrees F., nor during unsuitable weather.

34.4 Method of Measurement. Bituminous materials for prime coat shall be measured as specified in Section 33.

Bituminous material for tack coat diluted as prescribed above shall be measured in tons of the diluted mixture acceptably applied to the surface.

Sand blotter shall be measured in tons or cubic yards, as indicated by the unit appearing in the Estimate of Quantities and the Proposal, measured in the hauling vehicles at the point of loading, conforming to all requirements in the completed and accepted work.

34.5 Basis of Payment. Bituminous material for prime coat, measured as provided above, shall be paid for at the contract unit price bid per ton for the particular type of material required.

Bituminous material for tack coat, measured as provided above, shall be paid for at the contract unit price bid per ton for the particular type of diluted and blended material required.

Sand blotter, measured as provided above, shall be paid for at the contract unit price bid per ton or cubic yard for "Sand Blotter".

Payments specified above shall be full compensation for all labor, materials, tools, supplies, equipment and doing all work involved in applying the prime coat, tack coat and sand blotter as specified, including incidentals necessary to complete the work

The department reserves the right to increase or to omit all or any part of the estimated amount of sand blotter or tack coat to be used and no additional compensation shall be allowed by reason of such increase or decrease.

SECTION 35 - SEAL COAT

Slush ??

35.1 Description. Seal coat shall consist of an application of bituminous binder on a compacted and bonded bituminous surface and, if required, covering the application with a sand blotter.

35.2 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set out in this specification and in Part III, Material Details. Specific references to Part III are as follows:

Sand Blotter	Section 89
Liquid Asphalt	Section 91
Emulsified Asphalt	Section 92

35.3 Construction Methods. (a) Maintaining Traffic. Where public traffic is being routed over a surface upon which a seal coat is to be applied, the seal shall not be applied to more than one-half the width of the traveled way at a time, and the remaining half width shall be kept free of obstructions and open for use by public traffic at all times until the seal coat first applied is ready for use by traffic.

The contractor shall provide for the passage of public traffic through the work in accordance with the provisions of Section 11 of these specifications, and when ordered by the engineer, traffic shall be routed through the work under one-way control.

Bituminous binder shall not be spread later in the day than will permit the stopping of traffic control prior to darkness. Bituminous binder shall be applied to only one designated traffic lane at a time and the entire width of the lane shall be covered in one operation.

(b) Preparation of Base. Immediately before applying the bituminous binder the surface to be sealed shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until the metal in the surfacing is exposed and all dirt and loose material is removed from the entire width of the surfacing.

(c) Applying Bituminous Binder. Liquid asphalt and asphalt emulsion shall be applied at a temperature and in the manner specified under Section 33 of these specifications, for distributor application of the grade of liquid asphalt or asphalt emulsion being used.

Bituminous binder shall not be spread when weather conditions are unsuitable or when either the atmospheric or pavement temperature is below fifty (50) degrees F. When a surface treatment is to be applied to the central portion of the pavement, the seal coat shall be applied to the shoulders at least four (4) days in advance of the application of the adjacent surface treatment requiring screenings and the seal coats shall be applied in such a manner that the joint between the two types will present a neat and uniform appearance true to the line shown on the typical cross-section and as established by the engineer.

After the bituminous binder has penetrated the surface, the treated area shall be covered, where necessary, with sand blotter in sufficient quantity to absorb any excess of bituminous binder and prevent picking up by traffic.

The kind of bituminous binder and the rate of application shall be as indicated on the plans or in the special provisions.

After the surface has been opened to public traffic, any excess of bituminous binder that comes to the surface shall be immediately covered with additional sand blotter.

35.4 Method of Measurement. Quantities of liquid asphalt or asphaltic emulsion to be paid for will be determined in accordance with the procedure specified in Section 33 of these specifications.

The quantity of sand blotter to be paid for shall be the number of tons or the number of cubic yards, measured in the hauling vehicles at point of loading, as indicated by the unit stated in the proposal, conforming to all requirements in the completed and accepted work.

35.5 Basis of Payment. Bituminous binder, measured as provided above, shall be paid for at the contract unit price bid per ton for the particular type of material required.

Sand blotter, measured as provided above, shall be paid for at the contract unit price bid per ton or per cubic yard for "Sand Blotter".

Payments specified above shall be full compensation for furnishing all labor, materials, tools, supplies, and equipment and doing all the work involved in applying the seal coat and all incidental work connected therewith.

The department reserves the right to increase or omit all or any part of the estimated amount of sand blotter, and no compensation shall be allowed by reason of such increase or decrease.

SECTION 36 - SURFACE TREATMENT

36.1 Description. Surface treatment shall consist of an application of bituminous binder and cover of screenings applied on a previously compacted and bonded bituminous surface conforming to the typical cross-section shown on the plans and as herein specified.

36.2 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set out in this specification and in Part III, Material Details. Specific references to Part III are as follows:

Screenings	Section 84
Liquid Asphalt	Section 91
Emulsified Asphalt	Section 92

36.3 Construction Methods. (a) Maintaining Traffic. Where public traffic is being routed over a surface upon which a surface treatment is to be applied, the surface treatment shall not be applied to more than one-half the width of the traveled way at a time, and the remaining half width shall be kept free of obstructions and open for use by public traffic at all times until the surface treatment first applied is ready for use by traffic.

Traffic will not be allowed on the newly placed bituminous binder and screenings until, in the opinion of the engineer, the screenings and bituminous binder have sufficiently set and bonded to prevent displacement by such traffic.

When the newly completed surface treatment is open to traffic, the traffic shall be controlled by use of flagmen and a pilot car for a period of six (6) hours or for such time as deemed necessary by the engineer as follows:

A flagman shall be stationed at the beginning of each newly completed section open to traffic, to stop oncoming traffic preparatory to piloting operations and shall be kept on duty during the entire control period.

Traffic control as described above shall be moved ahead progressively as the newly completed surface is open to traffic.

The contractor shall provide for the passage of public traffic through the work in accordance with the provisions of Section 11 of these specifications and as outlined above.

(b) Preparation of Base. Immediately before applying the bituminous binder, the surface to be treated shall be thoroughly cleaned of all dirt and loose material by sweeping with power brooms supplemented by hand brooms if necessary. The process of cleaning shall continue until the surfacing is exposed and all dirt and loose material is removed from the entire width of surfacing.

(c) Applying Bituminous Binder. Liquid asphalt or emulsified asphalt shall be applied at a temperature and in the manner specified under Section 33 of these specifications, for distributor application of the type of liquid asphalt or emulsified asphalt being used.

The bituminous binder to be applied shall be liquid asphalt or emulsified

asphalt of the type set forth in the estimate of quantities and the proposal. The rate of application and the amount of screenings to be spread shall be indicated on the plans or in the special provisions.

Bituminous binder shall not be spread when weather conditions are unsuitable or when either the atmospheric or pavement temperature is below fifty (50) degrees F., or when sufficient screenings are not on hand to immediately cover the bituminous binder.

When surface treatment is specified for the central portion of the roadbed and a flush seal coat for the shoulders, the flush seal coat shall be applied at least four (4) days in advance of the application of the adjacent surface treatment and the applications shall be applied in such manner that the joints between the two types will present a neat and uniform appearance true to lines shown on the typical cross-section and as established by the engineer.

Bituminous binder shall be applied to only one designated traffic lane at a time and the entire width of the lane shall be covered in one operation.

When emulsified asphalt is prescribed as the binder material to be used work shall be suspended in periods of high humidity and shall not be resumed until humidity conditions are normal and weather conditions favorable.

(d) Spreading Cover Material. Immediately following the application of the bituminous binder, it shall be covered with screenings spread at the required rate per square yard.

Screenings shall be spread by means of a self-contained, self-propelled, pneumatic-tired power spreader so designed, equipped, coordinated, and operated that the screenings will be spread continuously and uniformly over the full width of the bituminous binder application in one operation and in such a manner that the coarser aggregates contact the bituminous binder first then the finer material on top filling the voids thereof. The spreading hopper shall be of ample capacity and be equipped with easily adjustable cut-off gates which will permit continuous straight spreads of from six (6) inches to thirteen (13) feet in width. The unit shall be capable of consistently obtaining the specified rate of application without segregation and shall be subject to the approval of the engineer as to type, size and mechanical condition. Whenever spreaders are found unsatisfactory by the engineer, they will be changed, replaced or removed from the work as he may require.

In order to avoid building a longitudinal joint, when spreading screenings on the first width of bituminous binder, no screening shall be applied within six (6) inches of the edge adjacent to the next application of bituminous binder.

Bituminous binder and screening shall not be spread over a greater distance than can be rolled and finished within one (1) days operation. The distance over which the binder is spread in advance of placing screenings shall be as determined by the engineer.

In order to eliminate dust film, screenings shall be moistened with water before being applied. In spreading the screenings, the equipment used shall be so operated that the fresh binder material will be covered before equipment wheels come upon it.

Asphaltic emulsion binders applied to the road surface shall be covered with screenings before setting or breaking of the binder occurs.

(e) Finishing. After the screenings have been spread upon the bituminous binder, any piles, ridges, or uneven distribution shall be carefully removed with flat bottom shovels, or other approved methods to insure against permanent ridges or humps in the completed surface. Additional screenings shall be spread by hand

in whatever quantities required to prevent picking up by the rollers or traffic, after which the surface shall be blanket rolled.

Rolling shall follow immediately behind spreading screenings to properly embed the screenings in the soft bituminous binder and rolling shall commence at the outer edges and proceed towards the center of each spread of bituminous binder and screenings, and shall be continued until the screenings are thoroughly set into the binder. Rollers shall be of the pneumatic-tired type and shall be heavy enough to set the screenings in the bituminous binder and shall be self-propelled, non-oscillating type and shall be capable of operating forward or backward without turning around on the roadbed.

After the screenings are set in the bituminous binder, but not earlier than the day following the spreading and compaction of screening, corrugations caused by loose screenings shall be removed.

After the surface has been opened to public traffic, any excess of bituminous binder that comes to the surface shall be immediately covered with additional screenings. The completed surface shall present a uniform appearance and shall be thoroughly compacted, and free from ruts, humps, depressions, or irregularities due to an uneven distribution of bituminous binder or screenings.

36.4 Method of Measurement. Bituminous binder shall be measured as specified in Section 33.

The quantity of screenings to be paid for shall be the number of tons or the number of cubic yards, measured in hauling vehicles at point of loading as indicated by the unit stated in the proposal, conforming to all the requirements in the completed and accepted surface treatment.

36.5 Basis of Payment. Bituminous binder measured as provided above, shall be paid for at the contract unit price per ton for the particular type of material required.

Screenings measured as provided above shall be paid for at the contract unit price bid per ton or per cubic yard for "Screenings", which price shall include moistening if required.

Payments specified above shall include full compensation for furnishing all labor, materials, tools, supplies, and equipment and doing all the work involved in applying the surface treatment as specified and all incidental work connected therewith, except that when the items of "Flagman" and/or "Pilot Car" appear as bid items in the proposal the necessary flagging and piloting shall be measured and paid for as specified in Section 11.

SECTION 37 - ARMOR COAT

37.1 Description. This item shall consist of the construction of a wearing course composed of three applications of bituminous material, each covered with mineral aggregate, placed upon a previously bituminized surface, or upon a thoroughly compacted base that has been given a prime coat, and which complies with the lines, grades, and cross-section shown on the plans.

37.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Coarse Aggregate	Section 84
Key Rock	Section 84
Screenings	Section 84
Liquid Asphalt	Section 91
Emulsified Asphalt	Section 92

37.3 Equipment. Mineral aggregate shall be spread at the specified rate by means of an approved mechanical spreader so designated that the material will be spread in a uniform sheet. The rate of spread shall be readily adjustable.

Rollers shall be self-propelled tandem type, weighing not less than eight (8) tons as prescribed in Article 29.2.

The blade graders used for leveling shall be of the self-propelled type, tightly articulated, having a wheel base of not less than sixteen (16) feet and a blade not less than ten (10) feet long. Stiff brooms with suitable devices for attaching to the blade of the grader or to the rollers shall be provided.

37.4 Construction Methods. When required on the plans or in the special provisions, a prime coat shall be applied in accordance with Section 34.

The sequence of the various operations and the approximate amount of materials shall be as shown in the following tables:

APPROXIMATE AMOUNT MATERIALS AND SEQUENCE OF OPERATIONS USING LIQUID ASPHALT

Operation	Materials Per Square Yard			
	Liquid Asphalt Gallons	Coarse Aggregate Pounds	Key Rock, Pounds	Screenings, Pounds
1st Application	0.15	----	----	----
1st Spread Blade, broom, roll	----	40	----	----
2d Application	0.30	----	----	----
2d Spread Blade, broom, roll	----	----	12	----
3d Application	0.15	----	----	----
3d Spread Blade, broom, roll	----	----	----	8
Approx. Total	0.60	40	12	8

APPROXIMATE AMOUNT MATERIALS AND SEQUENCE OF OPERATIONS USING EMULSIFIED ASPHALT

Operation	Materials Per Square Yard			
	Emulsified Asphalt, Gallons	Coarse Aggregate, Pounds	Key Rock, Pounds	Screenings, Pounds
1st Application	0.10	----	----	----
1st Spread Blade, roll lightly	----	36	----	----
2d Application	0.35	----	----	----
2d Spread Blade, broom, roll	----	----	16	----
3d Application	0.25	----	----	----
3d Spread Blade, broom, roll	----	----	----	8
Approx, total	0.70	36	16	8

In hot, dry weather, or when ordered by the engineer, aggregate shall be moistened before applying emulsified asphalt.

Bituminous material of the kind indicated on the plans or in the special provisions shall be applied in accordance with Section 33.

The first application of bituminous material shall be covered immediately with coarse aggregate which shall be bladed and broomed to a smooth, true, uniform surface. It shall then be rolled until the aggregate is thoroughly keyed together and embedded in the asphalt. In spreading the aggregate the truck shall be operated backward so that the fresh bituminous material will be covered before the truck wheels come upon it.

Each succeeding spread of aggregate shall be made promptly after applying the bituminous material, and shall be bladed and broomed to a smooth, uniform, true surface, and rolled until thoroughly set into the voids and keyed together. Such brooming as is necessary to distribute the aggregate uniformly shall accompany the rolling. Additional aggregate shall be applied by hand during the rolling and brooming operations to cover any bare or inadequately covered places.

The finished surface shall be smooth, uniform in appearance, and thoroughly bonded, except for a slight excess of loose screenings on the surface. Maintenance of the surface until completion of the contract shall include occasional redistribution of loosened screenings over the surface by brooming and additional rolling.

37.5 Method of Measurement. Bituminous material shall be measured as specified in Section 33.

The quantity of aggregate for armor coat to be paid for shall be the number of tons of each of the classes used, conforming to all requirements in the completed and accepted work.

37.6 Basis of Payment. Bituminous material, measured as provided above, shall be paid for at the contract unit price per ton, for the particular type of material required.

Aggregate, measured as provided above, shall be paid for at the contract unit price per ton for "Coarse Aggregate", "Key Rock", or "Screenings", as the case may be.

The quantity of water acceptably applied shall be measured and paid for as provided in Section 28.

Prime coat, when required, shall be measured and paid for as specified in Section 34.

Payments specified above shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 38 - ROADMIX SURFACE

38.1 Description. Roadmix surface shall consist of the construction of a surface course of mineral aggregate and bituminous binder mixed in place on the prepared roadbed, or mixed off of the roadbed by either roadmix or plantmix methods. The prepared mixture shall be spread and compacted upon a prepared subgrade or base in conformity with the grades, lines and dimensions shown on the plans and as specified in this section or in the special provisions, and as directed by the engineer.

38.2 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set out in this specification and in Part III, Material Details. Specific references to Part III are as follows:

Selected Material	Section 81
Aggregates for Roadmix and Plantmix Surfaces	Section 83
Liquid Asphalt	Section 91
Emulsified Asphalt	Section 92

Bituminous binder to be mixed with the mineral aggregate shall be asphaltic emulsion or liquid asphalt of the grade designated in the estimate of quantities and the proposal for that item of work, and shall be furnished and applied in accordance with the provisions of Section 33 of these specifications and as hereinafter specified. When more than one grade of bituminous binder is specified, the engineer will designate the specific grade or grades to be used.

The mineral aggregate shall conform to the requirements set forth above, or it may consist of the material in place on the roadbed; or a combination of one or more of these materials, as required by the plans or specified in the special provisions.

When the mineral aggregate consists of material in place on the roadbed, which was not placed under the contract providing for the placing of the roadmixed surfacing, all rock or lumps of materials larger in greatest dimension than the planned surface thickness shall be removed and disposed of along the roadway and such work shall be paid for as extra work as provided in Articles 4.5 and ~~9.5~~ 9.4 of these specifications.

38.3 Special Requirements. Attention is directed to Section 33 of these specifications.

The methods employed in performing the work and all equipment, tools, machinery and other appliances used in handling materials and performing any part of the work shall be subject to approval of the engineer before the work is started and whenever found unsatisfactory shall be changed or improved as required by the engineer. All equipment, tools, machinery and plant used must be maintained in a satisfactory working condition.

Equipment used shall include scarifying, mixing, spreading, finishing and compacting equipment, a self-powered bituminous material distributor, and equipment for heating bituminous material.

Motor graders for spreading, shaping and finishing mixture shall be of the self-powered type with blades not less than ten (10) feet long and wheel bases of not less than sixteen (16) feet. Such graders shall be not less than six (6) tons in weight and shall be equipped with pneumatic tires.

Either traveling or stationary mixing plants or other equipment of proven performance may be used by the contractor in lieu of specified equipment if advance written approval is given by the engineer, and if the contractor complies with such requirements as the engineer may consider necessary to insure results that will be at least equal to the results which would be obtained by use of the specified equipment.

When the plans require approaches and road connections, street intersection areas, sidewalk areas, median strip areas, gutters, ditches, areas around embankment protector assemblies, and other areas to be surfaced with roadmix surfacing material; and that shoulder dikes are to be constructed of roadmixed material, the mineral aggregate to be used for these purposes shall be the same as required for surfacing the roadbed.

At locations where public traffic is being routed over a roadbed upon which a roadmixed surface is being placed, the contractor shall provide for the passage of such traffic through the work in accordance with the provisions of Section 11 of these specifications and as herein set forth. When ordered by the engineer, traffic shall be routed through the work under one-way control.

38.4 Preparation of Roadbed. (a) Subgrade. The graded roadbed, in advance of placing the mineral aggregates thereon, shall be shaped to the required grade and cross-section, after which it shall be compacted to the required degree of compaction. When the roadbed is thus prepared to the satisfaction of the engineer, the required amount of mineral aggregate shall then be placed in accordance with the provisions of Section 30 of these specifications. If the mineral aggregate is to be treated with bituminous materials immediately after being placed, the compaction requirements of that portion to be incorporated in the mix will not be required.

The preparation of subgrade for roadmix surface to be placed in connection with surfacing special areas off the traveled way, when such areas are inaccessible to conventional equipment, shall be by the methods satisfactory to the engineer and made suitable for the purposes intended.

(b) Preparing In-Place Material. When the mineral aggregate to be bituminous treated consists of material in place on the roadbed, the area involved shall be scarified to such a depth that sufficient aggregate will be available to construct the roadmixed surface as planned, including the placing of surfacing material for special features off the traveled way as provided above, after which the scarified material shall be so broken up that when a sample of the material retained on a one-half (1/2) inch sieve is soaked in water, not over fifteen (15) percent, by weight, will pass the one-half (1/2) inch sieve.

When traffic is permitted to pass through the work, scarifying operations shall be limited to that area which can be treated with bituminous binder and mixed on the following day, except that when necessary for properly drying the material, scarifying may extend further with the engineer's written permission.

All rocks or lumps of material larger in greatest dimension than the thickness of the roadmix surfacing shown on the plans shall be removed from the scarified material and disposed of as specified above.

Material loosened below the required depth, as above provided, shall be spread, reshaped and thoroughly recompacted in advance of mixing operations, and no additional compensation will be allowed for such work.

In advance of the application of the bituminous material, the mineral aggregate shall be bladed and processed to secure a uniform mixture of fine and coarse material. If irregularities or segregations of materials occur during or after spreading, the aggregate shall be bladed into windrows, remixed until segregations are eliminated and then respread.

38.5 Prime, Tack and Seal Coat. If required by the special provisions or shown on the typical cross-section of the plan, a prime coat shall be applied to an untreated subgrade or a tack coat shall be spread on an existing bituminous surface used on a base for roadmix surfacing. The prime or tack coat shall be spread before roadmixing is begun or before premixed materials are deposited on the roadbed.

Prime coat or tack coat shall not be placed farther in advance of depositing or mixing operations than ordered by the engineer.

Asphaltic emulsion paint shall be applied to all vertical faces of curbs, gutters, construction joints and existing pavement, against which surfacing is to be placed and to such other areas as are designated by the engineer.

Prime coat and tack coat shall conform to the requirements of Section 34 of these specifications.

Immediately in advance of placing the surfacing material, the areas of primecoat or tack coat which have been destroyed or damaged shall be covered with the same type of bituminous material as originally used for this purpose.

When the proposal includes a contract item of asphaltic emulsion or liquid asphalt for seal coat, it shall be applied to the finished surface as specified under Section 35 of these specifications.

38.6 Placing Aggregate. Mineral aggregate consisting of material in place on the roadbed shall be scarified, broken up and processed as provided in Article 38.4(b) of this section.

Mineral aggregate consisting of material other than that in place on the roadbed shall be deposited upon the prepared subgrade, or mixing area, by the use of spreader boxes, or from the vehicles equipped or supplemented with suitable spreading devices. (should be of sufficient quantity).

The mineral aggregate shall contain sufficient material to construct the roadmix surfacing as planned, including sufficient material for surfacing special features off the traveled way. The aggregate shall not be mixed with earth or other deleterious matter.

Immediately prior to applying the bituminous material, the aggregate shall be tested for moisture content. If the moisture content is more than one and one-half (1-1/2) percent of the dry weight of the aggregate, the aggregate shall be

turned by blades or disc harrows or otherwise manipulated until the moisture content is reduced to one and one-half (1-1/2) percent or less. The prepared aggregate shall then be spread smoothly and uniformly over one-half of the roadbed or other convenient width, ready for the application of bituminous material except that when a traveling mixing plant is used the loose aggregate shall be formed into a windrow or windrows or into a blanket of uniform cross-section.

38.7 Applying Bituminous Binder. The bituminous binder shall be distributed uniformly in three approximately equal applications, as are determined by the engineer. It shall be applied at a temperature conforming to the range of temperatures specified under Section 33 of these specifications. Following closely, after each application of bituminous material the mixing equipment shall partially mix the aggregate and the bituminous binder so as to leave as little free bituminous material as possible. The intervals between applications of bituminous binder shall be as directed by the engineer.

Bituminous material shall not be spread when weather conditions are unsuitable nor when the atmospheric temperature or the temperature of the mineral aggregate is below fifty (50) degrees F.

No more bituminous material shall be applied per day than can be mixed with the aggregate on the same day it is applied.

38.8 Mixing. The materials may be mixed upon the roadbed, or upon some other approved area off the roadbed by roadmixing methods, or the material may be mixed at a central-mixing plant by plantmix methods as specified below, whichever the contractor elects.

(a) Roadmixing Methods. Prior to applying the bituminous binder the prepared aggregate shall be spread smoothly and uniformly over one-half the mixing area or some other convenient width. The first application of bituminous binder shall then be applied immediately after which the binder and aggregate shall be partially mixed. The remaining applications of bituminous binder with a partial mixing after each application shall follow in like manner. After the last application of bituminous material and partial mixing, the entire mass of bituminous binder and aggregate shall be windrowed on the mixing surface and then thoroughly mixed and combined by the mixing units specified, by blading the mix from side to side of the mixing surface, or by a manipulation producing equivalent results, until all particles are coated with bituminous binder and the whole mass has uniform color and the mixture is free from spots containing an excess or deficiency of binder, balls or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When so directed by the engineer, the mixing process shall be confined to part of the width or area of the roadbed so as to allow a convenient passage for traffic.

Prior to spreading and compacting, should the mixture show an excess or deficiency of bituminous binder, or an uneven distribution thereof, the condition shall be corrected by adding mineral aggregate or bituminous material, as the case may be, and then remixing to produce a satisfactory mixture. If necessary, all compressed masses of mixed materials shall be broken up. When the mineral aggregate consists of the existing material on the roadbed and an allowance for additional mineral aggregate has not been provided for on the plans, additional mineral aggregate may be obtained by scarifying material from the roadbed as

directed by the engineer, or in lieu thereof, the contractor may import suitable material. No additional compensation will be allowed for conforming to the above requirements, except that additional materials imported and added to that in place will be paid for on a Force Account basis for the work involved, in accordance with Articles 4.5 and 9.5 of these specifications. Spreading of the mixture shall not be done when the base to be covered is wet or until authorized by the engineer.

The amount of material mixed in any one day shall not be more than can be spread and compacted on the following day, provided, however, that when directed by the engineer, mixed material may remain in the windrow for a longer period.

In lieu of mixing the material as above specified, a roadmixing machine or any equipment other than that required above may be employed which will produce the completed mixture equal to that which would be produced by the means above specified. The department reserves the right to order the use of any equipment discontinued which, in the opinion of the engineer, fails to produce a satisfactory mixture.

The roadmixing machine shall be of the pugmill or auger type which picks up the loose material from the mixing area or it may be of the type which cuts a true plane in material at a specified depth, leaving no loose material in either case. Either type shall introduce the bituminous material through a metering device at the time of mixing. The machine shall be equipped to provide for a positive control of the amount of bituminous binder introduced into the mix, which can be readily adjusted to the changes required.

The rate of movement of the roadmixing machine, the amount of the material mixed and the amount of mixing shall be so regulated that a mix satisfactory to the engineer will result. The materials shall be mixed until a uniform mixture of unchanging appearance is obtained and all particles of aggregate are thoroughly coated with bituminous materials. Before mixing, the loose materials shall be placed in windrows or in a blanket of uniform cross-section and of such size that all the material in the windrow or blanket can be passed through the mixing machine at each mixing operation.

Materials mixed off of the roadbed shall be uniform in character and equal in all respects to that which would be produced by mixing on the roadbed as above specified.

(b) Plantmixing Methods. Should the contractor elect to mix the materials at a central-mixing plant by the plantmix method, the mineral aggregate shall be dryed, proportioned and mixed with the bituminous binder in accordance with the applicable requirements of Section 40 of these specifications with the following modifications:

When the moisture content of the mineral aggregate does not exceed three (3) percent by weight of the dry aggregate and laboratory tests indicate that such increased moisture content will not produce an unstable mixture, mixing of the materials without passing the aggregate through a dryer will be permitted, at the discretion of the engineer.

Unless otherwise specified in the special provisions, separation of the mineral aggregate into required sizes and storing in separate bins will not be required.

38.9 Spreading, Compacting and Finishing. Spreading and compacting equipment shall conform to the requirements of Section 40 of these specifications, except that the use of a self-propelled mechanical spreading and finishing machines will not be required.

Before the finished mixture is spread for compaction, a triangular cut shall be made with a motor grader at each edge of the base course to provide for a thickened edge of bituminous mixture. The cut shall be approximately two (2) inches deep at the outer edge and slope to zero two (2) feet in towards the center. In making a cut the excavated material shall be thrown to the edge of the roadbed in a small windrow against which the mixture shall then be spread.

After roadmixing operations have been completed and the mixture has been approved by the engineer, the mixture shall be uniformly spreadoover the area to be surfaced to the proper width and to such depth as will compact to the required thickness. Should the contractor elect to mix the materials prior to the delivery on the roadbed, as provided above, spreading the mixture on the roadbed shall begin at the point or points farthest from the point of mixing and shall progress continuously towards the point of mixing, unless otherwise ordered by the engineer. The mixture shall be spread by means of an approved spreader box.

Segregation of coarse or fine particles shall be avoided and the mixture shall be free from lumps or pockets of coarse and fine material after spreading.

After the mixture has been spread as above specified, approximately the top half of the material shall be removed by motor graders and placed into a windrow on one side. The windrow shall be so placed that earth or other extraneous materials will not become intermixed with the windrowed material. The exposed area not occupied by the windrow shall then be thoroughly rolled, after which the windrow shall be moved and the area occupied by the windrow shall be rolled. Rolling shall be continuous throughout the spreading operations. The windrowed material shall then be respread over the entire surface by alternating the windrow from one side of the roadbed to the other and to the center and gradually decreasing the amount of material moved, until the entire surface has uniform texture and is smooth and true to cross-section and grade and is uniformly compacted. During blading and rolling, all lumps and loose stones shall be moved to the outside of the surfaced area and disposed of.

All rolling, except the final finish rolling, shall be done with pneumatic-tired rollers. The finish rolling shall be done with steel-tired tandem or three-wheeled rollers commencing at the lower edge, progressing toward the highest portion. Under no circumstances shall the highest portion be rolled first.

38.10 Miscellaneous Areas to be Surfaced. Surfacing of approaches, street, intersection areas, service highways, sidewalk areas, median strip areas, and island areas shall conform to all of the requirements hereinbefore specified, except that the surfacing material may be spread and compacted in one coarse on sidewalk areas, median strip areas and island areas.

Surfacing material used in the construction of shoulder dikes; placed as

ditch lining; placed around embankment protector assemblies; and placed over other areas designated by the engineer, shall be spread by hand or by other approved methods in one course. The material shall be thoroughly compacted to the required lines, grades and cross-sections by means of mechanical tampers or by approved methods that will produce the same degree of compaction as mechanical tampers, except that shoulder dikes shall be shaped and compacted with approved equipment capable of shaping and thoroughly compacting the material to the required cross-section.

38.11 Method of Measurement. Quantities of bituminous binders of the type and grade set forth in the proposal to be paid for will be determined in accordance with methods in Section 33.

Roadmix surface

New mineral aggregate, conforming to all the requirements, in the completed and accepted work, will be measured either by the ton or cubic yard as indicated in the proposal. The measurement will be made as set forth in Section 9, Article 9.1 of these specifications, except that if the surfacing material is mixed at a central mixing plant by the plant-mix method the quantity to be paid for will be determined by weighing the completed mixture and deducting the weight of bituminous binder added thereto.

Mineral aggregate consisting of material in place on the roadbed will not be measured and paid for, except for the removal of rocks and lumps as provided in Article 38.2 of this section. All other work involved in scarifying and preparing the material as herein specified shall be considered as included in the contract unit price paid for mixing the roadmix surfacing.

Mixing and compacting shall be measured in miles along the centerline of the roadway and no extra allowance will be made for mixing widened sections and shoulder dikes, unless otherwise provided in the special provisions.

The quantity of shoulder dikes constructed of roadmixed material, the placing of which is to be paid for as a contract item on a linear foot basis, will be determined from measurements taken along the top of the completed dike to the nearest one (1) foot length. The quantities of bituminous binder and mineral aggregate used to construct the dike shall be measured as set forth above.

The quantity of mixing and compacting roadmix surfacing for intersections, approaches and other miscellaneous areas, except shoulder dikes and widened areas, to be paid for will be determined from horizontal measurements of the areas over which surfacing is placed in accordance with the provisions of Section 9, Article 9.1. Such measurements shall include only areas outside the limits of the nominal width of roadway specified for surfacing.

38.12 Basis of Payment. Bituminous binder, used in the mix and measured as provided above shall be paid for at the contract unit price bid per ton for the particular type of material applied.

Mineral aggregate, measured as provided above, shall be paid for at the contract unit price bid per ton or cubic yard, as the case may be, for "Roadmix Surface Aggregate".

Mixing and compacting, measured as provided above shall be paid for at the contract unit price bid per mile for "Roadmix".

Mixing and compacting of intersections, approaches, and other miscellaneous areas, measured as provided above, shall be paid for at the contract unit price bid per square yard for "Roadmix Intersections".

Placing and compacting roadmixed material for shoulder dikes, measured as provided above, shall be paid for at the contract unit price bid per linear foot for "Roadmixed Shoulder Dike".

Payment specified above shall include full compensation for furnishing all labor, materials, tools, supplies and equipment, and doing all the work involved in constructing and compacting the roadmix surfacing, including equipment, for shaping and compacting shoulder dikes and any necessary hand placing and hand compacting of the surfacing material as specified or ordered.

Watering, required to assist in subgrade preparation and compaction of mineral aggregates shall be measured and paid for as specified in Section 28 "Watering".

Rolling, required for compaction of the subgrade and for compaction of the untreated mineral aggregate shall be measured and paid for as specified in Section 29 "Rolling".

Prime or tack coat, if required, shall be measured and paid for as specified in Section 34 "Prime Coat".

Seal coat shall be measured and paid for as specified in Section 35 "Seal Coat".

SECTION 39 - RETREAD SURFACE

39.1 Description. This item shall consist of a surface course composed of coarse aggregate, key rock, and screenings uniformly mixed, penetrated, and bound together with emulsified asphalt, or rapid curing liquid asphalt, and placed upon an approved base in accordance with these specifications and in conformity with the lines, grades and cross sections shown on the plans. Two types are specified; the type applying shall be as shown on the plans or in the special provisions.

39.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Aggregate for retread	Section 84
Liquid Asphalt (RC Type)	Section 91
Emulsified Asphalt	Section 92

39.3 Equipment. Aggregate shall be spread by means of an approved mechanical spreader so designed that the material will be spread in a uniform sheet. The rate of spread shall be readily adjustable.

Blade graders for mixing and blading shall be of the self-propelled type with a wheel base of not less than sixteen (16) feet, shall have a blade not less than ten (10) feet long, and pneumatic tires. Stiff brooms with suitable devices for attaching to the blade of the grader shall be provided for the brooming. Mixing may be done with special mixers designed for this purpose, if, in the opinion of the engineer, results are as good as obtainable with blade graders.

Rollers shall be of the self-propelled tandem type weighing not less than eight (8) tons, as prescribed in Article 29.2.

39.4 Preparation of Base. When the base course is a water-bound type, it shall be given a prime coat in accordance with Section 34 of these specifications prior to starting the surface course.

Where an old bituminized or cement concrete surface course is to serve as the base, it shall be thoroughly cleaned by brooming to remove all dust and loose material, all soft asphaltic patches and joint material shall be removed, and all holes, depressions, and other irregularities shall be patched, built up, or otherwise corrected as directed by the engineer.

39.5 Construction Methods. Mineral aggregate shall be thoroughly dry when RC asphalt is applied. During hot, dry weather, coarse aggregate shall be sprinkled with water before applying emulsified asphalt. Bituminous material shall be applied in accordance with Section 33 of these specifications.

The sequence of the various operations and approximate amounts of material shall be as shown in the following tables:

ESTIMATED QUANTITIES - TYPE 1 RETREAD
(Compacted Thickness 1-1/2 inches)

Operation	Materials Per Square Yard of Surface					
	RC Asphalt gallon	Emulsified Asphalt, gal.		Coarse Aggregate lbs.	Key Rock lbs.	Screenings lbs.
		Mixing	Penetration			
1st Spread	- -	- -	- -	120	- -	- -
1st Application Mix	0.30	0.30	- -	- -	- -	- -
2nd Application Mix, shape, roll	0.30	0.30	- -	- -	- -	- -
2nd Spread Broom, roll	- -	- -	- -	- -	20	- -
3rd Application	0.40	- -	0.50	- -	- -	- -
3rd Spread Broom, roll Open to traffic	- -	- -	- -	- -	- -	10
4th Application	0.30	- -	0.40	- -	- -	- -
4th Spread Broom, roll	- -	- -	- -	- -	- -	15
Approx. Total	1.30	0.60	0.90	120	20	25

ESTIMATED QUANTITIES - TYPE 2 RETREAD
(Compacted Thickness 1-1/2 inches)

Operation	Materials Per Square Yard of Surface					
	RC Asphalt gallon	Emulsified Asphalt, gal.		Coarse Aggregate lbs.	Key Rock lbs.	Screenings lbs.
		Mixing	Penetration			
1st Spread	- -	- -	- -	135	- -	- -
1st Application Mix	0.35	0.35	- -	- -	- -	- -
2nd Application Mix, shape, roll	0.30	0.40	- -	- -	- -	- -
2nd Spread Broom, roll	- -	- -	- -	- -	14	- -
3rd Application Curing period Open to traffic	0.10	- -	0.10	- -	- -	- -
4th Application	0.20	- -	0.20	- -	- -	- -
4th Spread	- -	- -	- -	- -	- -	15
Approx. Total	0.95	0.75	0.30	135	14	15

Coarse aggregate shall be uniformly spread upon the base and bladed to a smooth surface and uniform cross-section. Immediately following the first application of bituminous material, coarse aggregate and bituminous material shall be mixed, either by blading from side to side of the road or by other suitable means. Mixing shall continue until all particles of the aggregate are covered. The material shall then be spread and given a second application of bituminous material before the first application has dried or set. Mixing, as specified above, shall be resumed immediately following the second application of bituminous material, and shall continue until all particles are coated and the mixture is uniform in appearance. The mixture shall then be bladed to a smooth surface, true to profile and cross-section.

When emulsified asphalt is used for the binder and begins to coalesce and strip from the aggregate, mixing or other manipulation shall be discontinued between the beginning of the set and complete adherence to the rock.

During the mixing and spreading, care shall be used to prevent disturbing the base or incorporating shoulder material into the mix.

After the mixture has been spread and is in the proper condition of tackiness, it shall be rolled so as to cover the whole surface once. The roller wheels shall be kept well moistened to prevent picking up of the mixture. After rolling once, all irregularities shall be removed by planing with a blade grader, and adding premixed material where required. Spots that tend to ravel, shall be removed and replaced with premixed material. The surface shall then again be rolled once over.

When the first application has set sufficiently so that it will not be indented by the wheels of the truck, key rock shall be spread in the required amount as shown by the above table. The amount shall be just sufficient to fill the voids in the coarse aggregate. Key rock shall be brommed until evenly distributed over the surface, and shall then be rolled until embedded into the voids of the coarse aggregate and the whole mass is thoroughly bonded and locked and all surface voids are filled. Rolling shall be accompanied by such brooming as is necessary to sweep the rock into the voids. Additional key rock shall be added by hand to any spots where there is a deficiency.

When the key rock has been rolled into the surface voids as specified above, the third application of bituminous material shall be applied. When Type 1 retread is specified, the third application of bituminous material shall be covered immediately with the first spread of screenings. The screenings shall be broomed and rolled and additional screenings shall be spread where required, as specified above for key rock. Rolling shall be resumed at the proper periods during several days. When Type 2 retread is specified, the third application of bituminous material shall not be covered, and shall not be disturbed until dry and thoroughly cured. The road shall then be opened to traffic for a period not less than ten (10) days. The surface shall then be swept clean of all dirt and loose material and a fourth application of bituminous material applied and covered immediately with an application of screenings. Brooming and rolling shall follow as specified above for other applications.

The finished surface shall be smooth, true to required cross-section, and free from ruts, humps, depressions, or irregularities. When tested with a straightedge ten (10) feet long placed on the surface parallel to the centerline, the surface shall at no point vary more than one-quarter (1/4) inch from the lower edge of the straightedge. Wherever excessively rich overlapping of joints has occurred,

the entire surface within such area shall be removed and reconstructed with rock and screenings, and treated with penetration type emulsion as directed by the engineer. All irregularities in the surface shall be patched with penetration type emulsion and screenings, the emulsion to be applied by means of a spray nozzle. Care shall be exercised in the application of the emulsion to insure that the total amount applied on the patches is not in excess of that specified in the table above.

Maintenance until completion of the contract shall include brooming to redistribute any loose screenings over the surface.

39.6 Method of Measurement. Emulsified and liquid asphalt shall be measured as specified in Section 33.

The quantity of aggregate to be paid for shall be the number of tons of each of the classes used, conforming to all requirements in the completed and accepted work.

39.7 Basis of Payment. Scraping and cleaning of old surfaces serving as a base shall not be paid for directly but shall be included in the contract prices for other items.

Prime coat when required shall be measured and paid for as specified in Section 34.

Emulsified or liquid asphalt measured as provided above shall be paid for at the contract unit price per ton for the particular type of material required.

Aggregate, measured as provided above, shall be paid for at the contract unit price per ton for "Coarse Aggregate," "Key Rock", or "Screenings", as the case may be.

The quantity of water acceptably applied shall be measured and paid for as provided in Section 28.

Payments specified above shall constitute full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, including patching, or building up of depressions, holes, or other irregularities.

40.1 Description. Plantmix surface shall consist of a combination of mineral aggregates and bituminous material mixed at a central mixing plant, and spread and compacted in one or more courses upon a prepared and approved base course in accordance with these specifications and conforming to the lines, grades, dimensions and number of courses shown on the plans or typical sections and as directed by the engineer.

This item shall also include plantmix base when it appears in the proposal. The plantmix base shall consist of mineral aggregates and bituminous material mixed at a central mixing plant, and spread and compacted in widening trenches on each side of the present surface as shown on the plans.

40.2 Materials. The materials furnished and used for this construction shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for the class, type and grade of material specified. Specific references to Part III Material Details are as follows:

Aggregate for Roadmix and Plantmix Bituminous Surfaces	Section 83
Liquid Asphalt	Section 91
Asphalt Cement	Section 93

Liquid asphalt used as prime coat shall be the type and grade designated in the Estimate of Quantities and the Proposal and shall be furnished and applied in accordance with the provisions of Section 34, the exact rate of application to be determined by the engineer.

Asphaltic emulsion used to paint vertical contact surfaces shall be a mixing type and shall be furnished and applied as hereinafter specified.

Asphaltic emulsion used as a tack coat over existing surfaces to be left in place or over bituminous base course or between surface courses when placing surfacing material in more than one course, shall be of the mixing type and shall be furnished and applied in accordance with the provisions of Section 34 and as hereinafter specified.

Bituminous material to be mixed with the mineral aggregate shall be liquid asphalt of the type, or asphalt cement of the penetration grade set forth in the Estimate of Quantities and the Proposal.

40.3 Equipment. (a) General Requirements for All Plants. The plant shall be so designed, equipped, coordinated and operated that the weighing, proportioning and mixing will yield a uniform mixture conforming to the requirements of these specifications, and within the tolerances fixed by the engineer.

The methods used in performing the work, and all equipment, tools, machinery, and other appliances used in handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and, wherever found unsatisfactory, shall be changed or improved to his satisfaction and so maintained in good working condition.

The name and description of the plant, factory-rated capacity of the mixer, full dimensions, openings and speed of screens shall be submitted to the engineer before starting the work.

Stockpile required

The plant shall be maintained in good mechanical condition and any defects, which affect the proper functioning of the plant or plant units or which adversely affect the qualities of the mixture, shall be corrected immediately.

Sufficient storage space shall be provided for stockpile of aggregate. The storage area shall be maintained neat and orderly and the stockpiles readily accessible for sampling.

Storage tanks for bituminous material shall be provided and the minimum storage capacity shall be twenty-five (25) tons or six thousand (6,000) gallons.

Tanks for the storage shall be equipped with a heating system capable of heating and holding the bituminous material at the required temperature. The heating system shall be designed to heat the contents of the tank by means of steam, electricity or other approved media, but flame shall not be placed in direct contact with the heating surface of the tank.

A circulating system adequate to insure a sufficient and continuous flow of the bituminous material between the storage tanks and the mixer unit during the operating period shall be provided. All pipe lines shall be steam jacketed or insulated to prevent undue loss of heat.

The plant shall be equipped with an accurate mechanical feeder for uniformly feeding the aggregate into the drier so that a uniform temperature will be obtained. The feed shall be either apron, belt, reciprocating plate, or vibrating type, with accurate and separate adjustments for total and proportional feed. The adjustments shall be capable of being locked in any position. The total and proportional controls shall be set and locked when so directed by the engineer.

The plant shall include a drier, capable of heating the aggregates to the required dryness and temperature and of continuously agitating the aggregate during this process. The drying capacity shall be sufficient to supply the mixing unit at its operating capacity, and at the required temperature.

Screening equipment shall be designed, constructed and operated in such manner that all aggregates will be uniformly separated into the specified sizes. It shall have sufficient capacity to furnish the necessary quantity of each aggregate size, when operating at normal capacity, without undue loss of efficiency and carry-over.

Bins which serve as storage space for the screened aggregate, shall contain at least two compartments. They shall be of sufficient size to supply the rated capacity of the mixer without reducing the screen efficiency to any appreciable extent. Each compartment shall be provided with an individual outlet gate, so designed and constructed that, when closed, there will be no leakage. The gates shall cut off quickly and completely.

Bituminous material shall be accurately proportioned by weight or by volume. Measurement by volume shall be made by means of approved meters or pumps, calibrated for accuracy.

An armored thermometer, reading from two hundred (200) to four hundred fifty (450) degrees F., shall be mounted in the asphalt line near the discharge valve at the mixer unit.

Mixing plants shall be provided with an approved type of dust collector and provisions shall be made to waste the material so collected or return it uniformly to the mixer as the engineer may direct.

An accurate pyrometer, the thermocouple of which shall be inserted in the discharge chute of the drier to register the temperature of the aggregate as it leaves the drier shall be installed. The instrument shall be clearly visible to the drum fireman or head feeder.

The contractor shall provide and maintain at the plant such other accurate thermometers as may be necessary to determine temperature.

All thermometric devices shall be maintained in good working condition and subject to checking against the laboratory thermometer.

Any instrument which does not operate or register properly shall be removed and repaired or replaced.

The mixer platform shall be sufficiently rigid and of ample size to provide for safe and convenient access to the mixer and other equipment pertinent thereto.

Adequate and safe stairways to the mixer platform and guarded ladders to other plant units shall be placed at all points required for accessibility to all plant operations.

All gears, pulleys, chains, and other dangerous moving parts shall be thoroughly guarded in accordance with the best practices of safe-guarding plant operations.

Clear, ample and unobstructed passageways shall be maintained in and around the plant and the truck loading space. Passageways, platforms, and ladders shall be kept free from oil drippings.

Truck scales shall be provided at each plant. Each truck shall be weighed empty and loaded.

All plant and truck scales and metering devices shall be inspected and sealed by the University of Nevada, Department of Weights and Measures.

The contractor shall furnish at his own expense for use in testing scales, one standard fifty (50) pound weight for each five hundred (500) pound of batch scale capacity for each individual installation.

The department reserves the right to prohibit the use of any drying, proportioning and mixing equipment which, in the opinion of the engineer, fails to dry and proportion the aggregates properly or fails to produce a satisfactory mixture.

(b) Batch Plant Requirements. (1) Scales - Scales used to weigh the bituminous materials shall be of the beam or springless dial types, Beam scales shall be equipped with tare and full capacity beams. Dial scales shall have a capacity of not more than fifteen (15) percent of the capacity of the mixer. The value of the minimum graduation shall not be greater than two (2) pounds.

Scales for the aggregate weigh box shall be of either the beam or springless dial type, of approved design, sensitive to one-half (1/2) of one (1) percent of the maximum required load. When of the beam type, there shall be a separate beam for each size of aggregate and a tare beam for balancing the hopper.

The scales shall be provided with a "tell-tale" dial which will start to function when the load being applied is within one hundred (100) pounds of that desired. Sufficient vertical movement shall be provided in the beams to permit the "tell-tale" to function properly. Each beam shall have a locking device designed so that the beam can be suspended or thrown out of action.

Dial scales shall be of approved design and of such size that the numerals can be read at a distance of twenty-five (25) feet. The dials shall be of the compounding type and have a full compliment of index pointers. Pointers so placed as to give excessive parallax errors shall not be used. Dial scales shall be substantially constructed, and those that easily get out of adjustment shall be removed and replaced when so ordered. All dials shall be located so as to be plainly visible to the operator at all times.

The scales shall be satisfactory to the engineer and shall be sealed, at the expense of the contractor, as often as he deems necessary to insure accuracy.

The weigh box shall be of sufficient size to hold the maximum required weight of aggregate for one batch without running over. The weigh box shall be supported on fulcrums and knife-edges so constructed that they will not be easily thrown out of alignment or adjustment. All parts of the weigh box shall be free from contact with any supporting rods, columns or other equipment which will affect the proper functioning of the hopper or scales. Sufficient clearance between the weigh box and supporting devices shall be provided to prevent accumulation of foreign materials.

The discharge gate of the weigh box shall be situated in such manner that the aggregates will not segregate when dumped into the mixer.

The bituminous material may be measured by an approved volumetric metering device, or weighed in an asphalt weigh bucket.

The weigh bucket shall be steam jacketed or electrically heated and shall have a capacity of not less than fifteen (15) percent of the maximum capacity of the mixer. It shall be supported on fulcrums and knife-edges.

The batch mixer shall be of an approved twin pug mill type, steam jacketed or heated by other approved means and capable of producing uniform mixtures within the specified tolerances. It shall be equipped with a sufficient number of paddles or blades set in proper order and operated at such speed as to produce a properly and uniformily mixed batch. The clearance of the paddles or blades from all fixed and moving parts shall not exceed one (1) inch. Badly worn or defective paddles or blades shall not be used in mixing operations. The blades or paddles shall be of a type adjustable for angular position on the shafts and reversible to retard the flow of the mix.

The mixer shall be provided with an approved time lock which will lock the discharge gate and will not release the gate until the time specified has elapsed.

The "dry mixing time" is the interval between the opening of the weigh box gate and the application of the bituminous binder.

The "wet mixing time" is the interval between the application of the bituminous binder and the opening of the discharge gate of the mixer.

Mixing time shall be set in the presence of and at the direction of the engineer who shall then lock the timing device gate. No further changes shall be made except on his instructions.

(c) Continuous-Plant Requirements. (1) Continuous mixing plants shall include a means for accurately proportioning each bin size of aggregate either by weight or volume. When gradation control is by volume, the unit shall include a feeder mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. The orifice shall be rectangular and of adequate dimensions to provide positive feed without bridging, with one (1) dimension adjustable by positive mechanical means and be provided with a lock. Indicators shall be provided to show the individual gate opening in inches.

The plant shall include a means for calibrating gate openings by weight. The materials fed out of the bins through individual orifices shall be by-passed to a suitable test box, each component material confined in a separate section. The plant shall be equipped to conveniently handle test samples weighing up to five hundred (500) pounds and accurate platform scales shall be provided for this purpose.

The bituminous material shall be introduced into the mixer through an accurate indicating meter by a positive displacement type pump. The pump shall be equipped with ready means of varying the rate of delivery of bitminous material. An approved means of weighing the delivery of bituminous material to the mixer shall be provided in order that the accuracy of asphalt delivery from the pump may be checked at intervals determined by the engineer. Positive interlocking control shall be afforded between the flow of aggregate from the bins and the flow of bituminous binder from the pump.

The plant shall include an approved twin pugmill type mixer, steam jacketed, or heated by other approved means. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mixture. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gage. The output of the plant in tons per hour shall not exceed the manufacturers rated output.

Unless otherwise required, determination of mixing time shall be by weight method under the following formula. The weights shall be determined for the job from a test made by the department.

$$\text{Mixing time in seconds} = \frac{\text{Pugmill dead capacity in pounds}}{\text{Pugmill output in pounds per second}}$$

(d) Spreading and Compacting Equipment. Unless otherwise provided, plant-mix surface shall be spread with self-propelled mechanical spreading and finishing equipment, provided with a screed or strikeoff assembly capable of distributing not less than the full width of a traffic lane. The screed shall be adjustable to the required template and elevation. The term "screeding" includes any cutting, crawling, or other action which is effective on the mixture without tearing, shoving, or gouging, and which produces a finished surface of even texture. The spreading and finishing machine shall be provided with rolling, tamping or other suitable compacting devices. If spreading and finishing machine leaves ridges, indentation, or other marks in the surface that cannot be eliminated by rolling, or prevented by adjustment in operation, its use shall be discontinued and other acceptable equipment shall be furnished by the contractor.

The self-propelled mechanical spreading and finishing machine shall be capable of propelling the vehicle being unloaded in a uniform manner, and if necessary, the load of the haul vehicle shall be so limited that satisfactory spreading will be obtained. While being unloaded, the haul vehicle shall be firmly attached to the machine and the brakes on the haul vehicle shall not be depended upon to obtain

obtain contact between the haul vehicle and the machine.

The spreading and finishing machine shall be capable of spreading mixtures without segregation in layers of three-quarters (3/4) inch to not less than three (3) inches in thickness and have a satisfactory device to adjust the spreading to grade and confine the edges to a true line.

Rolling equipment shall consist of power rollers of the tandem type, three wheeled type and self-propelled pneumatic-tired type.

Three-wheeled rollers shall be of rigid and sturdy construction and designed especially for bituminous type construction. The rollers shall have smooth operating clutches of the reversing type and smooth and efficient brakes.

All tandem rollers and three-wheeled rollers shall be equipped with sprinkling systems having water storage tanks of not less than seventy (70) gallons total capacity. The water shall be piped to the spray pipes on the rolls. The spray pipes shall extend the full width of roll and shall be so installed as to be readily cleanable. The water shall be distributed from the spray pipes through cocoa-fibre mats securely suspended against the rims. Separate valves shall control the water to each roll.

In addition to the above requirements, three-axle tandem rollers shall be so constructed that when the center or adjustable roll is locked in a position for all treads to be in one plane, it shall be held with a rigidity which will permit the following test under full load; with the weight of the roller supported on the center roll, the tread of the center roll shall not be more than one-eighth (1/8) inch above the plane tangent to the treads of the end rolls. With the weight of the roller supported on the end rolls, the treads of the center roll shall not be more than one-quarter (1/4) inch below the plane tangent to the treads of the end rolls. The two-axle tandem roller and three-wheeled roller shall weigh not less than eight (8) tons. The three-axle tandem roller shall weigh not less than ten (10) tons.

Self-propelled pneumatic-tired rollers shall have at least nine (9) wheels equipped with pneumatic tires of equal size and diameter, with treads satisfactory to the engineer. The tires shall be of the size recommended by the tire manufacturers and the tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by the tread of the following tire. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than five (5) pounds per square inch. Self-propelled pneumatic-tired rollers shall be so constructed that the total weight of the roller can be varied to produce an operating weight per tire of between one thousand (1000) and two thousand (2000) pounds, and during operation, the total operating weight of the roller shall be varied as ordered by the engineer. The rollers shall be adequately powered and have smooth operating clutches of the reversing type and smooth operating brakes of ample capacity. The rollers shall be capable of being operated both forward and backward without turning on the roadbed. The use of rollers which cause a loosening of the surface being rolled will not be permitted.

Self-propelled pneumatic-tired rollers shall be equipped with a tire wetting system for both front and rear tires. The water storage tank for the wetting system shall not be less than sixty (60) gallon capacity.

Trucks for hauling bituminous mixtures from the plant to the point of use shall have tight, clean and smooth metal beds, properly treated to prevent the mixture from adhering to the bed. Canvas covers shall be provided when ordered by the engineer to protect the mixture from the weather. Any truck causing excessive segregation of material, or that shows oil leaks in any magnitude, shall upon the direction of the engineer, be removed from the work until such conditions are corrected. The contractor shall at all times provide an adequate number of trucks to haul the continuous output of the mixing plant so that the mixture in the hopper of the spreading and finishing machine will not cool below specified temperature between loads.

40.4 Field Laboratory. The contractor shall provide a building conforming to the requirements of Section 79 "Field Laboratory". It shall be located so that the mixing platform is in full view from one of the windows. This field laboratory shall be for the exclusive use of the department's representatives.

40.5 Preparation of Mixtures. Fine material or filler, if required to meet specified grading, shall be blended with the aggregate before screening into separate compartments.

Aggregates shall be cleanly separated into at least two sizes and stored in separate bins ready for proportioning and mixing.

If a bin contains fifteen (15) percent or more material which is undersize for that bin, the bin shall be drawn down and the material rescreened.

At the time of mixing, the mineral aggregate shall not have an average moisture content in excess of one (1) percent. In certain special cases when the aggregate is unusually porous, a moisture content in excess of the above limit will be permitted at the discretion of the engineer, when laboratory tests indicate that such increased moisture content will not produce an unsatisfactory mixture. At the completion of mixing operation the amount of moisture in the mixture shall not exceed the limit above specified.

The temperature of the mineral aggregate at the time of adding the bituminous material, shall not be in excess of the following:

250° F. max. . . . . .Liquid Asphalt SC-4
275° F. max. . . . . .Liquid Asphalt SC-5
300° F. max. . . . . .Liquid Asphalt SC-6
325° F. max. . . . . .Asphalt Cement.

Liquid asphalt used as bituminous material shall be added to the aggregate at a temperature conforming to the range of temperatures as follows:

SC-4. . . . . .250° min - 325° F.
SC-5. . . . . .250° min - 350° F.
SC-6. . . . . .275° min - 325° F.

Asphalt cements used as bituminous binder shall be added to the aggregate at a temperature of not less than two hundred seventy-five (275) degrees F., nor more than four hundred (400) degrees F., the exact temperature to be designated by the engineer.

The exact proportions of mineral aggregate and bituminous material, within the limits specified, shall be regulated as directed by the engineer to produce a mixture with all the particles of mineral aggregate coated with bituminous material. The amount of bituminous material to be added to the mineral aggregate shall be between three (3) and seven (7) percent. The exact amount of bituminous material to be added to the mineral aggregate will be determined by the engineer at the time of mixing. When a greater amount of bituminous material is required to produce a satisfactory mixture, due to the porosity of the aggregate, the amount of bituminous material to be added to the aggregate shall be increased, above the limits specified, as ordered by the engineer.

When the mixture is produced in a batch plant, the component materials shall be accurately weighed within plus or minus two (2) percent of the total batch weight. The two or more sizes of aggregate shall be combined in uniform batches by weighing and conveyed to the mixer through a discharge gate on the weigh box that is so arranged as to blend the different sizes of aggregates as they enter the mixer. A weigh box that permits separation of sizes of aggregate in the ends of the mixer will not be permitted. The bituminous material shall be introduced into the mixer, by gravity distribution along the center of the mixer parallel to the mixer shafts, by means of a distributing pan fixed on the side of the mixer, or by pressure spraying. The pan shall be equipped with movable vanes in order that the flow of bituminous material may be directed across the width of the pan as desired. The vanes shall be equipped with a means of quick adjustment and a positive lock to prevent shifting. After the bituminous material is introduced into the mixer, mixing shall continue until a homogeneous mixture of uniformly distributed and thoroughly coated aggregates of unchanging appearance is produced. The "wet mixing time" shall not be less than thirty (30) seconds.

When the mixture is produced in a continuous mixing plant, the delivery of aggregates to the mill will be as hereinbefore set forth and at such rate that the composition of the finished mixture shall conform to these specifications and the established tolerances. The volume per unit of time shall be determined by weight at least once each day and as often thereafter as may be necessary to secure the desired uniformity. The aggregates shall be combined with the required quantity of bituminous binder as the materials enter the mixer. The rate of feed to the mixer shall be such that the combination of bituminous binder and aggregate shall be mixed for at least thirty (30) seconds, or as much longer as may be necessary to secure a homogeneous mixture of uniformly distributed and thoroughly coated aggregate of unchanging appearance.

40.6 Placing. Bituminous mixture shall be placed only on bases that are dry, when weather conditions are suitable and the atmospheric temperature is above fifty (50) degrees.

The base course shall be cleaned of all loose and foreign materials, primed, when required, and the contact surfaces of all curbing, gutters and other structures projecting into or abutting the pavement uniformly painted with a thin coating of asphaltic emulsion at the rate of from two-hundredths (0.02) to one-tenth (1/10) gallon per square yard of surface covered, the exact rate of application shall be determined by the engineer. The asphaltic emulsion shall be applied only as far in advance of surfacing as ordered by the engineer.

Unless otherwise specified, or specifically excepted, the base upon which bituminous mixture is to be placed shall receive a prime treatment conforming to the requirements of Section 34, at the rate or rates shown on the plans, the exact rate of application shall be determined by the engineer.

Prime coat shall not be applied until all subgrade preparations are complete, and only so far in advance of placing the bituminous mixture as the engineer may direct. After the bituminous material for prime coat has penetrated the surface, and if ordered by the engineer, the primed areas shall be covered with a sand blotter and spread in a quantity ordered by him.

Immediately in advance of placing the surfacing material, additional prime coat shall be applied, as directed by the engineer, to areas where the prime coat has been destroyed.

The bituminous mixture shall be delivered on the roadbed at a temperature of not less than two hundred twenty-five (225) degrees F. Higher temperatures are required when paving grade asphalts are used, but in no case shall the mixtures be delivered on the roadbed in excess of three hundred twenty-five (325) degrees F. The proper temperature within the above limits shall be as ordered by the engineer.

Tarpaulins shall be furnished by and at the expense of the contractor, and used to cover all loads during transportation, if ordered by the engineer.

The bituminous mixture shall be spread and compacted in one or more courses as indicated on the plans. Unless otherwise indicated on the plans or in the special provisions, when the compacted thickness is three (3) inches or more the surfacing shall be spread and compacted in two lifts of equal thickness.

All courses shall be spread by means of a self-propelled mechanical spreading and finishing machine.

There shall be operating with each spreader at least one (1) two-axle tandem or three-wheeled roller, one (1) self-propelled pneumatic-tired roller and one (1) three-axle tandem roller.

After the prime coat has been applied the first course shall be spread to proper width and to such depth as will compact to the required thickness.

After spreading and as soon as the mixture will bear the weight of the roller without undue distortion, the course shall be uniformly compressed by an approved three-wheeled roller or two-axle tandem roller. This initial compaction shall consist of two complete coverages. Immediately following the breakdown rolling and while the mix is quite hot additional density shall be obtained with a self-propelled pneumatic-tired roller weighing not less than five (5) tons. This rolling shall consist of at least eight complete coverages. Final rolling shall be performed with a three-axle tandem roller and shall continue until the layer is smooth, free from ruts, humps and irregularities and true to grade and cross section.

All rolling shall start longitudinally at the edge of the course and proceed toward the center of the pavement, overlapping on successive trips, approximately twelve (12) inches. On superelevated curves it shall progress from the lower side to the high side overlapping as above specified. The speed of the rollers shall be slow enough to avoid displacement of the hot material and rolling shall be a continuous process, so far as practicable. All parts of the mixture shall receive equal compaction. To prevent adhesion of the mixture to the rollers, the wheels shall be kept moistened but an excess of water will not be permitted. Any material which is marred or displaced by the rolling operations shall be corrected with rakes and the addition of fresh material.

When rolling adjacent lanes the rollers shall compress the joint by operating on the cold lane, lapping from six (6) to twelve (12) inches over the hot material and following immediately after spreading.

Construction of one course or lift upon another shall not proceed until the first of the two courses or lifts has been completely cooled and set.

Before a second lift or course is laid on the course previously completed, the previously laid course shall be clean and free of all mud, earth, dust and other foreign materials. The contractor shall furnish all equipment required for thoroughly cleaning the surface to be "tacked" or paved. The equipment shall consist of one or more mechanical sweepers of an approved type and also any scrapers, shovels and hand brooms deemed necessary.

A tack coat of asphaltic emulsion shall be applied to the first course in advance of spreading the next course as specified in Section 34.

Each course shall be spread, compacted and finished as above set forth.

Longitudinal and transverse joints in each course or lift shall be well bonded and made in a careful manner. If so directed by the engineer, joints, including those adjacent to existing construction, shall be painted with asphaltic emulsion. Longitudinal joints shall be spaced in such a manner that joints in succeeding courses will be at least three (3) inches horizontally from joints in any preceeding course. The longitudinal joint in the final course shall be within three (3) inches of the centerline of the finished surface.

During paving operations, the contractor, at his own expense, shall provide satisfactory planking to protect the longitudinal edges of the newly placed course from damage by his equipment.

When it is necessary to carry public traffic through the paving operations the first course or lift shall be constructed over the entire project before the second course or lift is laid, except when it is necessary to set up the plant at more than one location. The project shall be divided into increments of lengths determined by the engineer to best facilitate the handling of traffic. Traffic shall be kept off the surfacing area of each section during priming, placing, tacking and compacting operations and during the curing periods. During such operations traffic shall be maintained along one-half width of the roadbed. Warning signs, flares, flagmen and such other items shall be provided as set forth in Section 11, In addition, in order to minimize damage to the longitudinal joint adjacent to traffic, the contractor shall provide and place "traffic cones" to outline the edge of the newly placed surfacing. The "traffic cones" shall be painted a bright traffic yellow and suitably reflectorized, and shall be spaced approximately one hundred (100) feet apart. After dark, every fourth "cone" shall be provided with a flare set adjacent or on the "cone."

40.7 Plantmix Base Course. All of the foregoing articles shall apply to the plantmix base where applicable.

The plantmix base shall be spread with a spreader devised for distributing the bituminous mixture in the widening trench. The spreader shall be of a type manufactured by the All Purpose Spreader Company or an approved equal.

The base may be laid in one course and when compacted shall be no lower than the elevation of the existing bituminous surface and shall not exceed one-half (1/2) inch above that elevation. The degree of compaction shall be equal to the compaction obtained for plantmix surface. Pneumatic-tired equipment shall not be used for compaction unless it is specifically designed for compaction purposes.

40.8 Miscellaneous Areas to be Surfaced. Surfacing of intersecting roads, approaches, street intersection areas, truck parking areas, frontage roads (service highways), sidewalk areas, median strip areas, and island areas shall conform to all the requirements hereinbefore specified except at locations where the bituminous material is to be placed over areas inaccessible to the required spreading and compacting equipment or over areas where the use of required spreading and compacting equipment would be impractical, the mixed material may be spread and compacted in one course by other methods approved by the engineer.

Bituminous mixture used in the construction of shoulder dikes, placed around embankment protector assemblies; placed as ditch lining, except roadway ditches; and placed over other areas designated by the engineer, shall contain approximately fifty (50) percent more bituminous material than used in the mix placed on the surface of the roadbed. The exact amount of additional bituminous material shall be as ordered by the engineer and the bituminous mixture may be spread by hand or other approved methods in one course. After spreading, the material shall be thoroughly compacted to the required lines, grades and cross-section by means of pneumatic tampers, or by other methods approved by the engineer, that will produce the same degree of compaction as that obtained by pneumatic tampers, except that shoulder dikes shall be placed with approved equipment capable of shaping and thoroughly compacting the material to the required cross-section.

40.9 Surface Treatments. After the surface has been opened for use by public traffic for a period of time sufficient, in the opinion of the engineer, to have thoroughly compacted the entire surface, a surface treatment shall be applied to the traffic lanes as shown on the plans, this surface treatment shall be furnished and applied in accordance with the provisions of Section 36.

Plantmix paved ditches shall be given a seal coat furnished and applied in accordance with Section 35.

When indicated on the plans or set forth in the special provisions, plantmix surface placed outside the area designated to receive surface treatment shall be given a seal coat furnished and applied in accordance with Section 35.

40.10 Method of Measurement. Bituminous materials used in the mix either for surface or base shall be measured as specified in Section 33.

The quantity of plantmix surface or plantmix base to be paid for shall be the number of tons, conforming to all the requirements, in the completed and accepted work, less the weight of the bituminous material.

The quantity of shoulder dikes constructed of plantmix material, the placing of which is to be paid for as a contact item on a linear foot basis, will be determined from measurements taken along the top of the completed dikes to the nearest one (1) foot length. The quantities of plantmix surface used to construct the dikes shall be measured as set forth above.

The quantities of plantmix material, the placing of which is to be paid for as a contract item on an area basis in addition to the contract prices paid for the

plantmixed material will be determined from measurements of the plantmix material compacted in place.

40.11 Basis of Payment. The bituminous material used in the mix, either for for surface or base, measured as provided above, shall be paid for at the contract unit price bid per ton for "Liquid Asphalt, Type _____" or "Asphalt Cement _____ Penetration", as the case may be.

The quantity of surfacing placed on the roadbed, approaches, intersection areas, frontage roads (service highways), sidewalk areas, median areas, truck parking areas, and island areas, measured as provided above, will be paid for at the contract unit price bid per ton for "Plantmix Surface Aggregate" which payment shall be full compensation for furnishing all labor, materials, tools, supplies and for doing all work involved in placing the plantmix surface as above specified, including any necessary hand placing and compacting of surfacing material around drop inlets, manholes, embankment protectors, guard rail posts and other minor structures.

The quantity of plantmix base placed in the widening trenches, measured as provided above, will be paid for at the contract unit price bid per ton for "Plantmix Base Aggregate", which payment shall be full compensation for furnishing all labor, materials, tools, supplies and for doing all work involved in placing and compacting the plantmix base as above specified.

The quantity of plantmix surfacing used to construct ditch linings shall be paid for at the contract unit prices bid for surfacing placed on the roadbed as above specified. Placing the plantmix surfacing material in the ditch will be paid for at the contract unit price bid per square yard for "Plantmix Paved Ditches", which payments shall be full compensation for preparing the ditch subgrade, hauling, spreading and compacting the plantmixed material and for all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work.

The placing of plantmix material for shoulder dikes, measured as provided above will be paid for at the contract unit price bid per linear foot for "Plantmix Shoulder Dike" and the quantity of plantmix surfacing used to construct the shoulder dike shall be measured and paid for as prescribed for plantmixed material placed on the roadbed, which payments shall be full compensation for furnishing all labor, materials, tools, supplies and equipment and for doing all work involved in placing and compacting the plantmixed material complete in place as specified.

Prime coat and tack coat shall be measured and paid for as specified in Section 34.

Seal coat for plantmix paved ditches and other areas specified to receive a seal coat shall be measured and paid for as specified in Section 35.

Surface treatment shall be measured and paid for as specified in Section 36.

Sand blotter shall be measured and paid for as specified in Section 34.

Asphaltic emulsion for use as a paint and the coat of application, shall not be measured and paid for directly, but shall be considered a necessary part of the construction involved, and payment shall be considered as included in prices bid for other items of the work.

SECTION 41
(BLANK)

SECTION 42
(BLANK)

SECTION 43
(BLANK)

SECTION 44 - PORTLAND CEMENT CONCRETE

44.1 Description. Portland cement concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water, and when specified an air-entraining admixture, proportioned as herein specified.

44.2 Materials. The materials used shall be those prescribed for the several items which constitute the various mixtures and shall conform in all respects to all requirements for such materials as set out in Part III "Material Details". Specific references to Part III are as follows:

Water . . . . . Section 80
Coarse Aggregate for Portland Cement Concrete . . Section 85
Fine Aggregate for Portland Cement Concrete . . . Section 88
Portland Cement . . . . . Section 96

44.3 Classification. Concrete shall be of eight (8) classes: Class A, Class B, Class C, and Class D, for concrete without air-entraining, and Class AA, Class BA, Class CA, and Class DA for concrete with air-entraining. Each class of concrete shall be used in that part of the structure in which it is called for on the plans or where directed by the engineer. Requirements as set forth in the following table shall govern unless otherwise prescribed in the special provisions or shown on the plans.

TABLE I

Class of Concrete	Minimum Laboratory Compressive Strength at 28 days psi	Coarse Aggregate Size Number	Use
A AA	3000 3000	467 467	General use and reinforced sub-structures
B BA	3000 3000	357 357	Massive Sections or lightly reinforced sections
C CA	2500 2500	357 357	Massive unreinforced sections and backfill
D DA	3000 3000	67 67	Thin reinforced sections, handrails etc.

44.4 Admixtures. When the use of an air-entraining agent is specified it shall be added in a quantity which will result in an air content of from three (3) to six (6) percent as determined by the engineer on samples of freshly mixed concrete. It shall be measured accurately into each batch by equipment and methods approved by the engineer. Adjustments shall be made in the weights of the aggregates used per batch to compensate for increased yield due to air-entrainment.

so that the quantities of cement per cubic yard of concrete equals that specified. Such adjustments shall be made by decreasing the weight of fine aggregate without changing the weight of coarse aggregate unless otherwise ordered by the engineer.

When air-entrained concrete is specified, evidence based on tests made in a recognized laboratory shall be submitted to show that air-entraining admixture the contractor elects to use conforms to the requirements of the latest revision of AASHO M154 (ASTM C260) for 7- and 28-day compressive and flexural strengths and resistance to freezing and thawing, except as provided in the following paragraph. Tests for bleeding, bond strength and volume change will not be required. A "recognized" laboratory is any State highway, Bureau of Public Roads or cement and concrete laboratory regularly inspected by the Cement Reference Laboratory of the National Bureau of Standards. Tests may be made upon samples taken from a quantity submitted by the contractor for use on the project or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied.

An exception to the requirements in the preceding paragraph is the case of admixtures which are manufactured by neutralizing Vinsol resin with caustic soda (sodium hydroxide). When the contractor proposes to use such an admixture he shall submit a certification concerning the admixture in the following form:

> "This is to certify that the product (trade name) as manufactured and sold by the (company) is an aqueous solution of Vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to Vinsol resin is one part of sodium hydroxide to (number) parts of Vinsol resin. The percentage of solids based on the residue dried at 105° C. is (number). No other additive or chemical agent is present in this solution."

When the contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to or at any time during construction the engineer may require that the admixture selected by the contractor be further tested to determine its effect upon the strength of the concrete. When so tested, 7-day compressive strength of concrete made with the cement and aggregates in the proportions to be used in the work and containing the admixture under test in the amount sufficient to produce from three (3) to six (6) percent entrained air in the plastic concrete shall not be less than eighty-eight (88) percent of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixture.

The percentage reduction in strength shall be calculated from the average strength of at least five (5) standard six (6) inch by twelve (12) inch cylinders of each type of concrete. Specimens shall be made and cured in the laboratory in accordance with the requirements of the latest revision of AASHO T 126 (ASTM C 192)

and shall be tested in accordance with the requirements of the latest revision of AASHO T 22 (ASTM C 39). The percentage of entrained air shall be determined in accordance with the requirements of the latest revision of AASHO T 152 (ASTM C 231).

Admixtures failing to meet the above requirements may be rejected.

44.5 Equipment. Methods employed in performing the work, and all equipment, tools and machinery used for handling materials and executing any part of the work, shall be subject to the approval of the engineer. All equipment necessary shall be on hand and approved before concrete operations are begun by the contractor. When the contractor produces his own aggregates he shall install, at his own expense, a loading, screening, and washing plant of such design and capacity as will produce the quality and quantity of aggregates required for the work in accordance with these specifications.

The contractor shall maintain the equipment in good condition and adjustment. Concrete mixers and other equipment which are not adequate or suitable for the work as determined by the engineer shall be removed and suitable equipment shall be provided by the contractor at his own expense.

44.6 Protecting and Sampling Cement. Suitable means of storing and protecting the cement against moisture or other injurious effects shall be provided by the contractor. Sacks of cement, which for any reason, have become partially set or may contain lumps of caked cement shall be rejected and shall be immediately removed from the work.

Different brands of cement shall not be mixed during use or in storage, nor shall they be used alternately in any one class of construction. The same brand and kind of cement shall be used in a given structure above the ground line.

The sacked cement shall be so piled as to permit access for talley, inspection, and identification of each shipment.

The contractor shall obtain from the cement company from which the cement is purchased, a certificate stating that the cement delivered to the work complies with the specifications for the type of cement specified for use. One (1) copy of the certificate of compliance shall be mailed directly to the Materials and Research division, State Office Building, Carson City, Nevada and one (1) copy shall be delivered directly to the engineer in charge of the work.

Upon receipt of the certificate of compliance, the engineer may permit the use of the cement in advance of its release for use by the Materials and Research division. When a certificate of compliance is not furnished the engineer, the cement shall not be used in the work until a release for its use has been received by him from the Materials and Research division.

When a certificate of compliance is not furnished, the department shall be afforded sufficient time to make a 7-day test on approved brands of cement in common use, and a 28-day test on new or unapproved brands of cement.

Whenever it is determined by subsequent laboratory tests of mill or field samples that the cement does not comply with the specifications, subsequent use of cement from the same cement company will be delayed, if required by the laboratory, until tests can be made on each lot of cement delivered.

All cement not conforming to the specifications and all cement damaged by exposure to moisture shall be removed immediately and permanently from the work.

44.7 Storage of Aggregates. The handling and storage of aggregates shall be such as to prevent segregation or the admixture of foreign materials.

Adequate supplies of coarse aggregate shall be produced and stockpiled sufficiently in advance of construction operations as to permit sampling and testing before use.

If both crushed stone and gravel coarse aggregate are used in any one structure, they shall be stored separately. They shall not be mixed for use in successive batches, nor shall they be used alternately in any structure. Coarse aggregates secured from the same or different sources and which vary widely in gradation, shall be placed in separate stockpiles or bins and recombined in proportions required by the engineer. Different sizes of aggregates shall be stored in stockpiles sufficiently removed from each other to prevent the materials at the edges of piles from becoming intermixed.

In placing materials in storage or in moving them from storage to the mixer, any method which may cause the segregation, degradation or the combining of material of different gradings which will result in any stockpile or bunker failing to meet specified requirements shall be discontinued and the materials shall be reprocessed or wasted.

44.8 Proportioning. The proportioning shall consist of dividing the aggregates into the specified sizes, each stored in a separate bin, and recombining them with cement as herein provided.

All aggregates for use in Portland Cement Concrete shall be proportioned by weight, with the exception that aggregates for culvert headwalls, short pieces of curbs and gutter or small sections of sidewalk and related minor work may be proportioned either by weight or volume as the contractor may elect. Measuring boxes of known capacity shall be furnished and used to measure each size of aggregate proportioned by volume.

Batches requiring fractional sacks of cement will not be permitted, unless the contractor elects to weigh the cement in each batch.

Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the batch ingredients are released for discharge. The cement hopper may be attached to a separate scale for individual weighing or may be attached to the aggregate scale for cumulative weighing. For greater accuracy in cumulative weighing of cement, approved combinations of two dials on a single lever system may be used. If cement is weighed cumulatively, the cement shall be weighed before the other ingredients.

Scales utilized in the proportioning device may be of the springless dial type or of the multiple beam type.

If of the dial type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.

If of the multiple beam type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or

over or under weight. The indicator shall be so designed that it will operate during the addition of the last four hundred (400) pounds of any weighing. The over travel of the indicator hand shall be at least one-third (1/3) of the loading travel. The indicator shall be enclosed against moisture and dust.

All scales shall be tested as to accuracy and sealed by the University of Nevada, Department of Weights and Measures or its designated representatives, who will issue a certificate of inspection, stating the degree of accuracy of the scales. Scales shall be tested at the expense of the contractor as frequently as the engineer may deem necessary to insure their accuracy. The contractor shall furnish for use in testing scales, one standard fifty (50) pound weight for each five hundred (500) pounds of batch scale capacity.

The capacity of scales for weighing cement and aggregate shall not exceed that of the nearest commercial size of scales having a capacity of approximately one and one-half (1 1/2) times the total amount of material to be weighed by them in one operation. Each scale graduation shall be approximately one one-thousandth of the total capacity of the scale.

Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading and cutoff shall not vary from the weight designated by the engineer more than one (1) percent for cement, one and one-half (1 1/2) percent for any size of aggregate, nor one (1) percent for the total aggregate in any batch.

Should separate supplies of aggregate and material of the same size group, but of different moisture content of specific gravity be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the material therein completely exhausted before starting upon another.

The moisture content of the aggregate shall be such that no visible separation of moisture and aggregate will take place during transportation from the proportioning plant to the point of mixing. Aggregate containing excess moisture shall be stockpiled prior to use until sufficiently dried to meet the above requirements.

Variations in moisture shall not exceed one (1) percent of the weight of the aggregates in a saturated surface dry condition. If the contractor changes the source of any size of aggregate, opportunity shall be given in advance of use to permit the engineer to determine specific gravity and grading. Such aggregates shall not be used until necessary changes in batch weights and mixing water have been made.

Batches with cement in contact with damp aggregates shall be mixed within thirty (30) minutes after being proportioned. Batch trucks hauling more than one batch of cement and aggregate shall be so constructed that materials do not flow from one compartment to another during haul or discharge.

Quantities of each ingredient for the batch size to be used shall be set by the engineer and not changed except upon his order. The exact amount of each ingredient so set shall be incorporated into each batch. Corrections based upon the laboratory determinations, necessitated by the variation from day to day in

the moisture content of the raw materials or for other similar reasons, shall be made as directed by the engineer.

Coarse and fine aggregate shall be handled and measured separately. Cement shall be measured by the bag as packed by the manufacturer. Each bag shall contain ninety-four (94) pounds net and shall be emptied directly into changing skip of the mixer. Water shall be measured either by volume or by weight.

The engineer, subject to the requirements related herein shall fix and designate respective amounts of materials to be used in the mix for each class of concrete, including the amount of water. The sum of the weights of fine and coarse aggregate designated for each class shall equal the weights shown in the total aggregate column for the respective types of material. Within the range of the tabulation, the engineer shall designate the proportions of fine aggregate which, using the materials furnished, will produce a workable mix of the consistency herein specified with the least amount of water. If during construction, concrete at any time is found unsatisfactory, the contractor shall readjust his batch, subject to the requirements of Table II, as ordered by the engineer, until the mix actually being used on the job complies with all the requirements.

The contractor shall combine the cement, water, fine aggregate, and coarse aggregate into uniform batches, by incorporating into each batch the number of bags of cement and amount of water designated by the engineer, and weighing into each batch the respective weights of fine and coarse aggregate designated by the engineer in accordance with the following tabulation:

TABLE II

Class	Coarse Aggregate Used	Weight of Fine Aggregate per bag of Cement		Total Weight Aggregate Per Bag of Cement
		Minimum Pounds	Maximum Pounds	
A	* Rounded	190	225	570
A	* Angular	195	225	510
AA	* Rounded	175	210	540
AA	* Angular	180	210	480
B	* Rounded	210	250	730
B	* Angular	220	250	640
BA	* Rounded	200	235	700
BA	* Angular	205	235	610
C	* Rounded	280	320	900
C	* Angular	295	320	800
CA	* Rounded	260	300	820
CA	* Angular	280	315	770
D	* Rounded	230	250	530
D	* Angular	230	250	480
DA	* Rounded	190	225	480
DA	* Angular	190	225	430

* When coarse aggregate contains some rounded and some angular particles an interpolation shall be made between the amounts shown.

For each class, the pounds of coarse aggregate shall be the difference between the pounds shown in the total aggregate column and the pounds of fine aggregate as fixed and designated. The above tabulation is based on an apparent specific gravity of 2.65 for both fine and coarse aggregate. Corrections shall be made for variations therefrom, job materials, of more than five hundredths (0.05) up or down. The weights are based on dry aggregates.

44.9 Amount of Water and Consistency. The amount of water required for the proper consistency of concrete shall be determined by the slump test in accordance with the current "Standard Method of Slump Test for Consistency of Portland Cement Concrete," ASTM Designation: C143 and shall be within the following range:

Class A and Class AA	1 to 4 inches
Class B and Class BA	1 to 3 inches
Class C and Class CA	1 to 3 inches
Class D and Class DA	1 to 4 inches

The above ranges represent the extreme limits of allowable slump. In all cases the amount of water used as determined by the engineer, shall be the minimum necessary to secure the required workability of the concrete.

The amount of water added at the mixer shall be regulated in accordance with the free water in the aggregates and the requirements for workability within the limits of slumps set forth above. Free water in aggregates is defined as the total water minus the water absorbed by the aggregates in a saturated, surface-dry condition.

The equipment for measuring and upplying the water to the mixer shall be so constructed and arranged that the amount of water added to the mixture can be measured positively and that the predetermined quantity of water required can be discharged rapidly in one operation into the mixing drum without dribbling. The equipment shall be so designed that water from the source of supply cannot enter the measuring tank while the water is being discharged from the measuring tank into the mixer. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than one (1) percent from the required quantity of water for any position of the mixer with respect to level plane. The tanks or other equipment shall be so arranged as to permit the checking of the amount of water delivered by discharging into measured containers.

44.10 Machine Mixing. All Portland cement concrete shall be mixed in batch mixers of approved type and size except when the quantity required is too small to justify the use of a batch mixer.

Concrete mixers may be either of the revolving drum or revolving blade type.

The first batch of concrete materials placed in the mixer shall consist of a mixture of sand, cement and water sufficient in amount to cover the inside surface of the mixing drum with a coating of cement mortar. Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned. The material used for coating the mixer shall be considered as incidental to the work and no additional compensation will be made for it.

All concrete shall be mixed for a period of not less than one (1) minute after all materials, including water are in the mixer. During the period of mixing, the drum, or mixing blades shall operate at the speed for which it has been designed. Such speed, however, preferably shall not bee less than one hundred and seventy-five (175) nor greater than two hundred and twenty-five (225) feet per minute at periphery of the drum, or mixing blades, and not less than fourteen (14), nor more than twenty (20) revolutions per minute. The entire contents of the mixer shall be removed from the drum before materials from the succeeding batch are placed therein, and the mixer preferably shall be equipped with mechanical means for preventing the addition of aggregates after mixing has commenced.

The mixer shall be equipped with adequate water storage and a device for accurately measuring the amount of water used in each batch and shall be equipped with a batch meter or other device for accurately recording the number of revolutions for each batch and an attachment for automatically locking the discharging device so as to prevent the emptying of the mixer until the materials have been mixed the minimum specified times. No mixer shall be operated above its rated capacity and no mixer shall be used which has a rated capacity of less than one (1) bag batch. Pickup and throw-over blades in the drum of the mixer which are worn down three-quarters (3/4) of an inch or more in depth must be replaced by new blades.

44.11 Hand Mixing. Hand mixing shall not be permitted, except in case of an emergency and under written permission of the engineer. When permitted, it shall be done only on water tight platforms. The sand shall be spread evenly over the platform and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of uniform color, after which it shall be formed into a "crater" and water added in the amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and re-turned at least six (6) times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand-mixed batches shall not exceed one-half (1/2) cubic yard in volume. Hand mixing will not be permitted for concrete to be placed under water.

44.12 Retempering. Concrete shall be mixed only in such quantities as are required for immediate use and shall be placed before initial set has taken place. Any concrete in which initial set has begun shall be wasted and not used in the work. No retempering of concrete shall be allowed.

44.13 Ready-Mixed Concrete. Ready-mixed concrete may be used if approved by the engineer. Approval will be given if investigation of the plant and delivery system indicates that the concrete delivered to the site of the project will conform in all respects with the requirements of these specifications and the special provisions.

Ready-mixed concrete shall include central-mixed, shrink-mixed and transit-mixed concrete and except as modified in these specifications, shall conform to the current "Standard Specifications for Ready-Mixed Concrete", ASTM Designation: C94. Shrink-mixed concrete is that which has been mixed partially in a stationary mixer and the mixing completed in a truck mixer.

The size of batch in truck mixers and truck agitators shall not exceed the rated capacity as determined by the current "Standard Requirements of Truck Mixer Manufacturers Bureau". The size of batch in stationary mixers shall not exceed the rated capacity of the mixer as determined by the standard requirements of the "Associated Contractors of America". No batches requiring fractional sacks of cement will be permitted unless all of the cement is weighed when added to the batch.

If the use of ready-mixed concrete is approved, the producer shall use only that cement approved by the state for use on the project and such cement shall be reserved for use on the project for which authorization has been given. State tested cement shall be stored at the concrete plant in such a manner that it can be identified and kept separate from other cement. If the cement is handled in bulk, a separate storage bin shall be provided for it unless otherwise authorized by the engineer.

Ready-mixed concrete shall be transported in truck mixers or truck agitators only.

The mixer, when loaded to capacity, shall be capable of combining the ingredients of the concrete within the specified time, into a throoughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity. The agitator, when loaded to capacity, shall be capable of maintaining the mixed concrete in a thoroughly mixed uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Slump tests may be made of individual samples taken at approximately the one-quarter (1/4) and three-quarter (3/4) points of the load and if the slumps differ by more than two (2) inches, the mixer or agitator shall not be used until the condition is corrected. If the slump test is not satisfactorily met by mixers when operated at the minimum specified mixing time and loaded to capacity, or by agitators when loaded to the capacity, the equipment may still be used when operation with a longer mixing time or with a smaller load will produce concrete that will meet the slump test.

Mixers and agitators shall be examined daily for changes in condition due to accumulation of hardened concrete or mortar or to wear of the blades. When any such change of condition is found, the concrete should be subjected to the slump tests. If the tests indicate that the concrete is not being properly mixed, the faulty equipment shall be corrected before its further use is allowed.

When a truck mixer is used either for complete mixing or to finish the partial mixing done in a stationary mixer, each batch of concrete shall be mixed for not less than fifteen (15) nor more than one hundred (100) revolutions of the drum or blades at the rate of rotation designated by the manufacturere of the equipment as mixing speed. If any additional mixing is done, it shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When truck mixer or truck agitator is used for transporting concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within one (1) hour after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, a delivery time of less than one (1) hour may be required. When a truck mixer is used for the complete mixing of the concrete the mixing operations shall begin within thirty (30) minutes after the cement has been intermingled with the aggregate.

The organization supplying concrete shall have sufficient plant capacity and transporting apparatus to insure continuous delivery at the rate required. The rate of delivery of concrete shall be such as to provide for the proper handling and placing of concrete. An interval of more than forty-five (45) minutes between any two consecutive batches or loads, or a delivery and placing rate of less than eight (8) cubic yards of concrete per hour shall constitute cause for shutting down work for the remainder of the day and, if so ordered by the engineer, the contractor shall make, at his own expense a construction joint at the location and of the type directed by the engineer in the concrete already placed.

Ready-mixed concrete may be used for the construction of curbs and gutters when gutters do not exceed eight (8) feet in width and either of the following two methods used.

(a) Prior to placing concrete in forms, it shall be dumped from the truck mixer or agitator, on a platform of sufficient size to hold at least one-third (1/3) cubic yards. The concrete shall then be placed in the forms.

(b) The concrete may be poured directly from the truck mixer into the form if the concrete is compacted by internal vibration or if other approved methods are used which will prevent segregation.

Ready-mixed concrete may be used for the construction of structures if satisfactory means such as recombining chutes or other equipment is used that will permit the concrete to be placed without segregation.

After mixing of ready-mixed concrete has been completed it shall be agitated continuously at agitating speed until it has been discharged from the drum.

Concrete manufactured by any procedure which results in any unmixed lumps of cement in the mixed product shall be rejected.

The contractor shall use a ticket system for recording the transportation and delivery of batches from the plant to the site of the work. The tickets shall be issued to the truck operator at the plant for each load and shall be signed by the plant inspector, the vehicle driver, and the supplier, to certify that the concrete in the truck has been inspected prior to the departure and shall state the time the truck left the batching plant. The tickets shall be delivered to the inspector at the site of the work. Loads which do not carry such tickets and which do not arrive in satisfactory condition shall not be used in the work. All tickets for recording transporatation of batches shall be on standard Delivery Report forms furnished by the department, a copy of which appears at the end of this section.

44.14 Cold Weather Operations. No concrete shall be mixed or placed when the atmospheric temperature is below forty (40) degrees F. without written permission of the engineer, and then only when adequate means are employed to heat the aggregate and water and protect the concrete from freezing after being placed.

Before concrete is placed in any form or around any reinforcement or on any surface, all ice, snow and frost shall be completely removed and the temperature of all surfaces in contact with the concrete raised above the freezing point. No concrete shall be placed on a frozen subgrade or on one that contains frozen materials.

Arrangements for covering or housing the newly placed concrete shall be made in advance of placement and shall be adequate to maintain in all parts of the concrete

the temperature and moisture conditions specified below. When air temperatures do not fall below thirty (30) degrees F. artificial heat will not be required if the concrete surface is covered with forms or with canvas arranged so that air space is maintained between the canvas and the concrete. For lower temperatures, sufficient, well distributed, artificial heat shall be provided inside the coverings or enclosures around the concrete to maintain an air temperature of forty (40) degrees F. or above at the coldest point without exceeding eighty (80) degrees F. at the hottest point.

Housings may be of wood, Sheetrock, Celotex, canvas, tarred paper, plywood, or other suitable materials as long as they are reasonably tight and safe from wind and snow loadings. Housings and enclosures shall be built with fire resistant materials as far as practicable. Adequate fire fighting apparatus shall be furnished in easily accessible locations whereever enclosures are constructed. Attendants shall be retained on the job at all times to provide continuous operation of the heating units.

Housing and enclosures shall be left in place for the entire curing period specified below, or as directed by the engineer, except that sections may be temporarily removed as required to permit placing additional forms or concrete, provided they are replaced as soon as the form or concrete is in its final position.

At the end of the curing period, artificial heating shall be discontinued and housing removed in such manner that the fall in temperature at any point in the concrete will not exceed twenty (20) degrees F. in twenty-four (24) hours.

Newly placed concrete shall be kept at a temperature of not less than fifty (50) degress F. for seven (7) days or not less than seventy (70) degrees F. for three (3) days and then maintained at a temperature of at least forty (40) degrees F. for the next four (4) days. The temperature of the hardened concrete surface shall not be permitted to exceed one hundred (100) degrees F. at any time during the curing period. The methods of construction and curing shall be such that the loss of moisture from the concrete is not excessive during the curing period.

For air temperatures not lower than thirty (30) degrees F. the mixing water shall be heated to bring the temperature of the concrete at the mixer to between fifty (50) degrees F. and eighty (80) degrees F.

For air temperatures between thirty (30) degrees F. to zero (0) degrees F. both the water and the fine aggregate shall be heated to bring the temperature of the concrete at the mixer to between fifty (50) degrees F. and ninety (90) degrees F. Only coarse aggregate that is free from frozen lumps shall be used.

For air temperatures below zero degrees F. (0° F.) the water, the fine aggregate and the coarse aggregate shall all be heated to eliminate frost and to bring the temperature of the concrete at the mixer to between fifty (50) degrees F. and ninety (90) degrees F.

Mixing water shall be heated under such control and in sufficient quantities so that appreciable temperature fluctuations from batch to batch are avoided. To avoid flash set where either aggregate or water is heated to a temperature in excess of one hundred (100) degrees F. the loading of the mixture shall be in such sequence that the cement does not come in contact with such hot materials.

Aggregates shall be heated in such a manner that frozen lumps, ice and snow are eliminated and over heating and excessive drying is avoided. At no point shall the aggregate temperature exceed two hundred and twelve (212) degrees F. and the average temperature of an individual batch of aggregate shall not exceed one hundred and fifty (150) degrees F. The use of steam coils is recommended for heating aggregate.

When aggregates in stockpiles, cars or trucks are thawed or heated by means of steam coils, the exposed surface shall be covered with tarpaulins as much as practicable to maintain a uniform distribution of heat and prevent formation of frozen crust.

A permanent temperature record shall be kept, showing the date, hour, outside air temperature, and temperatures at several points within the enclosure and at the concrete surface to show the highest and lowest temperatures of the concrete surface. The use of thermometers imbedded in the concrete surface is suggested. Thermometer readings shall be taken at the start of work in the morning and again in the late afternoon. The data so obtained shall be recorded in such manner that the location of each reading and any conditions which might have an effect on the temperature will be shown. A copy of the temperature records shall be provided the engineer for reference.

The contractor shall assume all risk in the placing of concrete in cold weather, and permission given to place concrete under the above conditions shall in no way relieve the contractor of responsibility for proper results. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced at the contractor's expense.

44.15 Basis of Payment. Portland cement concrete will be measured and paid for in accordance with the provisions specified in the various sections of these specifications covering construction requiring concrete.

Cement lost, wasted or used for patching, grouting or in concrete poured outside the dimensions shown on the plans or the dimensions ordered by the engineer shall be deducted before making measurement and payment.

STANDARD FORM OF DELIVERY REPORT

STATE OF NEVADA

DEPARTMENT OF HIGHWAYS

CONTRACTOR'S DELIVERY REPORT OF

READY-MIXED CONCRETE

PROJECT NO. _____

CONTRACT NO. _____

STRUCTURE _____

The following described load of Ready-Mixed Concrete, Class _____ furnished by _____ conforms to department specifications and the requirements of the engineer.

VEHICLE LOADED _____ A.M. / P.M.

VEHICLE LICENSE NO. _____

CERTIFIED RATED CAPACITY _____ Cu. Yds.

QUANTITY THIS LOAD _____ Cu. Yds.

_____
Signature of Plant Inspector

_____
Signature of Supplier or an authorized representative

VEHICLE ARRIVED _____ A.M. / P.M. VEHICLE UNLOADED _____ A.M. / P.M.

Was the sample analyzed for entrained-air on this load _____

Entrained Air _____ %

Were slump tests taken on this load _____ Slump _____ in.

Location of load in structure _____

_____
Signature of Driver Signature of Inspector at site

_____
(If load was rejected - reasons for rejection)

_____

Distribution as follows: Original - Contractor; Yellow - Materials Lab.; Green - Inspector; Pink - Supplier

45.1 Description. This item shall consist of furnishing and placing Portland cement concrete in bridges, culverts, headwalls, retaining walls, and all other types of concrete structures. The concrete structures shall be constructed to the lines and grades given by the engineer and in accordance with the design shown on the plans; the concrete shall be of the class or classes of concrete designated in the proposal and on the plans and shall meet the requirements of Section 44, "Portland Cement Concrete" of these specifications. Unless otherwise specified, Class AA concrete shall be used.

45.2 Materials. Cement, aggregates, water, air-entraining admixtures, shall conform to the requirements of Section 44. Type II "low alkali" cement shall be used in all structures, unless otherwise provided.

The materials used shall be those prescribed for the several items which constitute the finished work and shall conform with all requirements for such materials as set forth in Part III, "Material Details". Specific references to Part III are as follows:

Asphalt Joint Filler	Section 94
Asphalt for Dampproofing and Waterproofing	Section 95
Miscellaneous Metals	Section 98
Expansion Joint Filler	Section 112
Curing Agents for Concrete	Section 114

45.3 Depth of Footings. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximate only and the engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

45.4 Forms. All forms shall be of wood or metal and shall be built mortar-tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations. Forms previously used shall be thoroughly cleaned of all dirt, mortar and foreign matter before being reused. Before concrete is poured in forms all inside surfaces of the forms shall be thoroughly coated with an approved form oil. Form oil shall have high penetrating qualities leaving no film on the surface of the form that can be absorbed by the concrete.

When requested by the engineer, the contractor shall submit detailed plans of form work for examination by the engineer. If such plans are not satisfactory to the engineer, the contractor shall make such changes as may be required, but it is understood that the engineer's concurence in the use of the plans as submitted or corrected shall in no way relieve the contractor of responsibility in obtaining satisfactory results.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration on the concrete as it is placed.

Forms for exposed surfaces shall be made of dressed lumber or plywood of uniform thickness with or without a form liner of an approved type and mortar-tight.

Forms shall be filleted at all sharp corners. Triangular molding used for fillets shall have two (2) equal sides. In general, the width of the equal sides of moldings shall be three-fourths (3/4) inch; for massive work, such as heavy pier copings and columns, the width shall be one and one-half (1-1/2) to two (2) inches. Top edges of walls, curbs and slabs shall be rounded with an edging tool to a radius of one-half (1/2) to three-fourths (3/4) inch. All edges of concrete rails and rail posts to be rounded to a radius of one-eighth (1/8) inch to one-quarter (1/4) inch.

When concrete is placed in excavation, forms shall be provided for all vertical surfaces unless otherwise ordered by the engineer. On thin walls, such as abutments, wing walls, and retaining walls, the forms on one face shall be built up as the concrete is poured, but only to such elevation as will permit proper placing and thorough spading, and in no case greater than the height which can be placed in one day's run. Ports shall be provided in high, thin walls to permit thorough cleaning before placing concrete.

If the forms develop any defects, such as bulging or sagging, after the concrete has been poured, that portion of the work shall be removed and reconstructed, as directed by the engineer, without additional compensation to the contractor.

During the erection and after the completion of the forms, they shall be protected in such manner as to preclude shrinkage, warping, curling, and distortion. Form lumber used a second time shall be free from bulge or warp and shall be thoroughly cleaned.

Forms for concrete over or in the vicinity of operating railroads shall be so constructed and placed that standard clearances demanded by the railroad company will be maintained at all times.

Falsework and forms supporting concrete beams, arch ribs, slabs, or other members subject to direct bending stress and forms on the inside of culverts, shall not be removed or released in less than fourteen (14) days after the concrete has been placed, unless concrete test cylinders show a strength of not less than twenty-five hundred (2,500) pounds per square inch in compression when cured under conditions affecting the structure. At times of low temperature or other adverse conditions, the engineer may increase the setting time to twenty-eight (28) days.

The falsework and forms supporting the bottom slab of the superstructure or box girder structures shall remain in place until the curing period of the deck of the superstructure has expired. Forms for the webs of box girders shall be removed before the deck slab is poured. Forms supporting the concrete deck or box girders may be left in place. All interior forms in box girders except those permitted to remain in place, shall be completely removed and the inside of the box girder cleared of all loose material and swept clean.

Side forms for beams, girders, columns, railing or other members of the structure wherein the forms do not resist dead load bending may be removed within a period from two hours to seven (7) days as permitted by the engineer, provided that satisfactory arrangements are made for curing and protecting the concrete thus exposed.

The side forms for arch rings, columns, and piers shall be removed before the members of the structure which they support are poured or placed, so that the quality of the concrete may be inspected. All such side forms shall be so constructed that they may be removed without disturbing other forms which resist direct load or bending stresses.

Forms for all surfaces, which will not be completely enclosed or hidden below the finished surface of the ground, shall be made of surfaced lumber or a material which will provide a surface at least equally satisfactory. Any lumber or material which becomes badly warped or checked prior to placing of the concrete shall be rejected.

Curved surfaces shall be formed of strips of matched lumber not over four (4) inches wide or of other material, such as plywood or metal, which has been approved by the engineer.

Forms for the railing may be made of metal, plywood, masonite, or of tongue and groove surfaced lumber. The workmanship shall be equivalent to first class pattern work. Bolts shall be used to hold railing forms together.

Forms for curbs, copings, and the outer edges of deck slabs, shall have a thickness of not less than one and five-eighths (1-5/8) inches or equivalent and a width of not less than the full depth of the curb, coping or slab.

The forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of forms to remain.

Forms shall be of sufficient strength to carry the dead weight of the concrete as a liquid without appreciable deflection, and if any deflection occurs it shall be sufficient cause for rejection of the work.

Forms for girders and slabs shall be cambered in such amount as may be required by the engineer.

Approved form clamps or bolts shall be used to fasten forms. The use of ties consisting of twisted wire loops to hold forms in position during the placing of concrete will not be permitted.

Bolts or form clamps shall be positive in action and shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back one (1) inch below the finished surface of the concrete. All forms for the outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales.

When plywood forms are shown on the plans or specified in the special provisions, they shall be constructed of plywood or a material which will produce a surface substantially equal to that which would result by the use of plywood forms.

Plywood for forms shall be "exterior Type", of the grade "Concrete-Form Exterior", conforming to the specifications of the U.S. Department of Commerce, National Bureau of Standard, Commercial Standards, latest edition. Form panels shall be furnished and placed in four (4) foot widths and in uniform length of not less than eight (8) feet, except where the dimensions of the member form are less than the specified panel dimensions. Where form panels are attached directly to the studding or joists, the panel shall not be less than five-eighths(5/8) inch thick and the studding or joists shall be spaced not more than twelve (12) inches center to center. Form panels less than five-eighths (5/8) inch thick, otherwise conforming to the requirements herein.

specified, may be used with continuous backing of three-quarter (3/4) inch surfaced material. All form panels shall be placed in a neat symmetrical pattern subject to the approval of the engineer. The panel shall be placed with a long dimension horizontal. Horizontal joints shall be level and continuous and vertical joints when shown on the plans or specified in the special provisions, shall be staggered and perpendicular thereto.

45.5 Falsework. The contractor shall submit detailed plans for falsework and centering for examination by the engineer. If such plans are not satisfactory to the engineer, the contractor shall make such changes in them as may be required, but it is understood that the engineer's concurence in the use of the plans as submitted or corrected shall in no way relieve the contractor of the responsibility of obtaining satisfactory results. Such plans shall be furnished on tracing paper or linen twenty-two (22) inches by thirty-six (36) inches in size or the prints in triplicate at the option of the contractor.

All falsework or centering shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of superstructures for box girders spans shall be designed to support the loads that would be superimposed were the entire superstructure poured at one time.

For designing falsework and centering, a weight of one hundred and fifty (150) pounds per cubic foot shall be assumed for green concrete. Falsework or forms shall be constructed to produce in the finished structure the lines and grades indicated on the plans. Suitable screw jacks or wedges shall be used in connection with falsework or centering to set the forms to grade or cambered as shown on the plans, or to take up any settlement in the form work either before or during the placing of concrete.

Falsework or centering shall be founded on a solid footing safe from undermining and protected from softening. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which will be spaced, driven and removed in a manner approved by the engineer.

Centering shall be removed uniformly and gradually, beginning at the crown and working toward the spring, to permit the arch to take its load slowly and evenly. Centering for bridges having two or more adjacent arch spans shall be struck simultaneously.

45.6 Reinforcement. Reinforcing shall be furnished and placed as shown on the plans and in accordance with the applicable provisions of Section 87 of these specifications and any requirements of the special provisions.

45.7 Mixing Concrete. All concrete shall be mixed as specified in Section 44, "Portland Cement Concrete", of these specifications, and the proportions of aggregate, cement and water shall be as established by the engineer, who shall have authority to vary these proportions as necessary during the pour.

The amount of water to be used in mixing concrete for concrete structures shall be of the least amount possible and yet sufficient to provide a workable mix

for the particular part of the structure in which the concrete is to be placed. The mixer shall be of sufficient capacity to pour the largest continuous run specified, within an eight (8) hour working day.

45.8 Handling and Placing Concrete. (a) General. In preparation for the placing of concrete all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These temporary members shall be entirely removed from the forms and not buried in the concrete.

No concrete shall be used which does not reach its final position in the forms within the time stipulated under Section 44.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall be permitted, only on written authorization of the engineer. In case an inferior quality of concrete is produced by the use of such conveyors, the engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.

Open troughs and chutes shall be of metal or metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.

All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the structure.

When placing operations would involve dropping the concrete more than five (5) feet, it shall be deposited through sheet metal or other approved pipes. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete. After initial set of the concrete the forms shall not be jarred and no strain shall be placed on the ends of reinforcement bars which project.

All concrete, except concrete placed as pipe culvert headwalls, slope paving, ditch paving, curbs, gutters, sidewalks, driveways and concrete placed under water, shall be compacted by means of mechanical vibration subject to the following provisions:

(1) The number of vibrators employed shall be ample to consolidate incoming concrete to a proper degree within fifteen (15) minutes after it is deposited in the forms. In all cases, at least two vibrators shall be available at the site of the structures in which more than twenty-five (25) cubic yards is being placed.

(2) The vibration shall be internal unless special authorization of other methods is given by the engineer or as provided herein.

(3) Vibrators shall be of a type and design approved by the engineer. They shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute.

(4) The intensity of vibration shall be such as to visibly affect a mass of concrete of one (1) inch slump over a radius of at least eighteen (18) inches.

(5) The contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms.

(6) Vibrators shall be manipulated so as to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

(7) Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.

(8) Vibration shall be supplemented by such spading as is necessary to insure smooth surfaces and dense concrete, along form surfaces and in corners and locations impossible to reach with the vibrators.

(9) The provisions of this article shall apply to the filler concrete for steel grid floor except that the vibrator shall be applied to the steel.

Concrete shall be placed in horizontal layers not more than twelve (12) inches thick except as hereinafter provided. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding batch has taken initial set to prevent injury to the green concrete and avoid surfaces of separation between the batches. Each layer shall be compacted so as to avoid the formation of a construction joint with a preceding layer which has not taken initial set.

When the placing of concrete is temporarily discontinued, the concrete, after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible upon exposed faces the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, as in the sloped top surface of a wing wall, an insert form work shall be used to produce a blocked out portion in the preceding layer which shall produce an edge thickness of not less than six (6) inches in the succeeding layer. Work shall not be discontinued within eighteen (18) inches of the top of any face, unless provision has been made for a coping less than eighteen (18) inches deep, in which case, if permitted by the engineer, the construction joint may be made at the under side of the coping.

Immediately following the discontinuance of placing concrete all accumulations of mortar splashed upon the reinforcement steel and the surfaces of forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If the accumulations are not removed prior to the concrete becoming set care shall be exercised not to injure or break the concrete-steel-bond at and near the surface of the concrete, while cleaning the reinforcement steel.

(b) Culverts. In general, the base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. In this case, suitable provision shall be made for bonding the sidewalls to the culvert base, preferably by means of longitudinal keys so constructed as to prevent, as far as possible, the percolation of water through the construction joint.

Before concrete is placed in the sidewalls, the culvert footing shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material and the surface carefully chipped and roughened in accordance with the method of bonding construction joints as specified herein.

In the construction of box culverts four (4) feet or less in height, the sidewalls and top slab may be constructed as a monolith. When this method of construction is used any necessary construction joints shall be vertical and at right angles to the axis of the culvert.

In the construction of box culverts more than four (4) feet in height, the concrete in the walls shall be placed and allowed to set before the top slab is placed. In this case, appropriate keys shall be left in the sidewalls for anchoring the cover slab.

Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.

(c) Girders, Slabs and Columns. Concrete, preferably, shall be deposited by beginning at the center of the span and working from the center toward the ends. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers.

Concrete in girder haunches less than three (3) feet in height shall be placed at the same time as that in the girder stem, and the column or abutment tops shall be cut back to form seats for the haunches. Whenever any haunch or fillet has a vertical height of three (3) feet or more, the abutment or columns, the haunch and the girder shall be placed in three successive stages; first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided.

Concrete in T-beam or deck girder spans may be placed in one continuous operation or may be placed in two separate operations, each of which shall be continuous; first, to the top of the girder stems, and second, to completion. In the latter case, the bond between stem and slab shall be positive and mechanical, and shall be secured by means of suitable shear keys in the top of the girder stem. The size and location of these keys shall be computed. In general, suitable keys may be formed by the use of timber blocks approximately two (2) by four (4) inches in cross-section and having a length four (4) inches less than the width of the girder stem. These key blocks shall be spaced along the girder stems as required, but the spacing shall be not greater than one (1) foot center to center. The blocks shall be beveled and oiled in such manner as to insure their ready removal, and they shall be removed as soon as the concrete has set sufficiently to retain its shape.

Concrete in columns shall be placed in one continuous operation, unless otherwise directed. The concrete shall be allowed to set at least twelve (12) hours before the caps are placed.

Unless otherwise permitted by the engineer, no concrete shall be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns. The load of the superstructure shall not be allowed to come upon the bents until they have been in place at least fourteen (14) days, unless otherwise permitted by the engineer.

(d) Arches. The concrete in arch rings shall be placed in such a manner as to load the centering uniformly.

Arch rings, preferably, shall be cast in transverse sections of such size that each section can be cast in a continuous operation. The arrangement of the sections and the sequence of placing shall be as approved by the engineer and shall be such as to avoid the creation of initial stress in the reinforcement. The sections shall be bonded together by suitable keys or dowels. When permitted by the engineer, arch rings may be cast in a single continuous operation.

45.9 Pumping. Placement of concrete by pumping will be permitted only if specified in the special provisions or if authorized by the engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

45.10 Depositing Concrete Under Water. Concrete shall not be deposited in water except with the approval of the engineer and under his immediate supervision; and in this case the method of placing shall be as hereinafter designated.

Concrete deposited in water shall be Class A with ten (10) per cent excess cement. To prevent segregation, it shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom dump bucket or other approved method, and shall not be disturbed after being deposited. Still water shall be maintained at the point of deposit and the forms under water shall be water-tight.

For parts of structures under water, when possible, concrete seals shall be placed continuously from start to finish; the surface of the concrete shall be kept as nearly horizontal as practicable at all times. To insure thorough bonding, each succeeding layer of a seal shall be placed before the preceding layer has taken initial set.

A tremie shall consist of a tube having a diameter of not less than ten (10) inches, constructed in sections having flanged couplings fitted with gaskets. The tremies shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of work so as to prevent water entering the tube and shall be entirely sealed at all times; the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete. The flow shall be continuous until the work is completed.

Depositing of concrete by the drop bottom bucket method shall conform to the following specification. The top of the bucket shall be open. The bottom doors shall open freely downward and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete. The slump of concrete shall be maintained between four (4) and eight (8) inches.

Unwatering may proceed when the concrete seal is sufficiently hard and strong. All laitance or other unsatisfactory material shall be removed from the exposed surface by scraping, chipping or other means which will not injure the surface of the concrete.

45.11 Construction Joints. Construction joints shall be made only where located on the plans or shown in the pouring schedule, unless otherwise approved by the engineer.

Construction joints where the placing of concrete is delayed until the concrete has taken its initial set and for which no expansion is provided, shall be planned in advance and shall be subject to approval by the engineer. The placing of concrete shall be continuous from joint to joint. These joints shall be perpendicular to the principal lines of stress and, in general, located at points of minimum shear. No concrete work shall be stopped or temporarily discontinued within eighteen (18) inches of the top of any finished surface unless such work is finished with a coping having a depth of less than eighteen (18) inches, in which case, the joints shall be made at the underline of the coping. A joint not shown on the plans will not be permitted in a cantilevered member. Horizontal joints at piers and abutments, except where specified, shall generally be avoided, and when used shall not be located within two (2) feet of the normal water level.

All construction joints shall be made with bulkheads provided with keyways whose areas are approximately one-quarter (1/4) of the cross-sectional area of the joint. When making a horizontal construction joint, care shall be taken to have the concrete as dry as possible, and any excess water or creamy material shall be drawn off before the concrete sets. On all exposed surface, the line of the proposed joint shall be made truly straight by tacking a temporary straight-edge on the inside of the form and pouring the concrete so that it will set flush with the edge as provided.

Construction joints not shown on the plans and above ordinary low water, in abutments and retaining walls that retain earth fills, shall be waterproofed on the back with a thirty-six (36) inch strip of waterproofing, as directed by the engineer, at the contractor's expense.

In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft or porous material with a stiff wire brush to expose the sound aggregate beneath, and, if deemed necessary by the engineer, shall be roughened with a steel tool. The surface then shall be thoroughly washed with clean water and painted with a thin coat of neat cement mortar, and the forms tightened to close contact with the previously placed work, after which the concreting may proceed.

When the work is unexpectedly interrupted by breakdowns, storm, or other causes, and the concrete as placed would produce an improper construction joint, the contractor shall either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section on which there is shearing stress, he shall provide adequate mechanical bond across the joint by inserting reinforcing steel, or by some other means satisfactory to the engineer, which will prevent a plane of weakness.

45.12 Cyclopean Concrete. Cyclopean concrete shall consist of either Class B or BA, or C or CA concrete, as specified, containing large embedded stones. It shall be used only with the approval of the engineer in massive piers, gravity abutments, and heavy footings. The stone for this class of work may be one-man stone or derrick stone conforming to the requirements of Section 87.

The stone shall be carefully placed - not dropped or cast - so as to avoid injury to the forms or to the partially set adjacent masonry. Stratified stone shall be placed upon its natural bed. All stone shall be washed and saturated with water before placing.

The total volume of the stone shall not be greater than one-third of the total volume of the portion of the work in which it is placed. For walls or piers greater than two (2) feet in thickness, one-man stone may be used; each stone shall be surrounded by at least six (6) inches of concrete; and no stone shall be closer than one (1) foot to any top surface nor any closer than six (6) inches to any coping. For walls or piers greater than four (4) feet in thickness, derrick stone may be used; each stone shall be surrounded by at least one (1) foot of concrete; and no stone shall be closer than two (2) feet to any top surface nor closer than eight (8) inches to any coping.

45.13 Removal of Falsework, Forms and Housing. In the determination of the time for the removal of falsework, forms and housing, and the discontinuance of heating, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the materials used in the mix.

If field operations are not controlled by beam or cylinder tests, the following periods, exclusive of days when the temperature is below 40° F, for removal of forms and supports may be used as a guide:

Arch centers	14 days
Centering under beams	14 days
Floor slabs	14 days
Walls	12-24 hrs.
Columns	1-7 days
Sides of beams and all other parts	12-24 hrs.

If high-early strength cement is used these periods may be reduced as directed by the engineer.

If field operations are controlled by beam or cylinder tests, the removal of forms, supports and housing, and the discontinuance of heating and curing may be begun when the strengths reach values which shall be fixed by the engineer for the particular method of testing which is to be used. The beams or cylinders shall be cured under conditions which are not more favorable than the most unfavorable conditions for the portions of the concrete which the beams represent.

Method of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without the approval of the engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.

In general, arch centering shall be struck and the arch made self-supporting before the railing or coping is placed. This precaution is essential in order to avoid jamming of the expansion joints and variations in alignment. For filled spandrel arches, such portions of the spandrel walls shall be left for construction subsequent to the striking of centers, as may be necessary to avoid jamming of the expansion joints.

Centers shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure. In arch structures of two or more spans, the sequence of striking centers shall be specified or approved by the engineer.

45.14 Curing. Freshly poured concrete shall be kept continuously wet for a period of not less than seven (7) days by covering with heavy absorbent mats or wet earth, by ponding, or by continuous sprinkling. If Type III cement is used, the curing period may be reduced as directed by the engineer. When absorbent mats are used, they shall be wet sufficiently to keep the surface adjacent to the concrete surface moist at all times. After the period of water curing, concrete surfaces shall be protected from the direct rays of the sun for an additional three (3) days. During this time the surfaces may be allowed to dry out slowly. In no case shall alternate wetting and drying of the concrete be permitted. In cold weather the period of curing shall be extended as directed by the engineer.

Absorbent mats for curing concrete shall conform to the requirements of Section 114.

When required by the special provisions or approved in writing by the engineer, structures or portions of structures as specified may be cured by means of an approved impervious membrane.

The membrane shall consist of a practically colorless impervious liquid of a type specified in Section 114 and approved by the engineer. Any membrane material which would alter the natural color of the structure will not be permitted.

The liquid shall be applied under pressure with a spray nozzle in such a manner as to cover the entire surface to be cured with a uniform film and shall be of such charcater that it will harden within thirty (30) minutes after application. The amount of liquid applied shall be ample to seal the surface thoroughly. Application of the liquid shall be made immediately after forms are removed and finishing operations have been completed. Prior to the application of the liquid the concrete shall be protected and kept moist as required herein.

45.15 Expansion and Fixed Joints and Bearings. All joints shall be constructed according to details shown on the plans.

(a) Open Joints. Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless so specified on the plans.

(b) Filled Joints. Poured expansion joints shall be constructed similar to open joints. When premolded types are specified, the filler shall be placed in correct position as the concrete on one side of the joint is placed. When the form is removed, the concrete on the other side shall be placed. Metal water stops shall be carefully placed as shown on the plans.

(c) Steel Joints. The plates, angles or other structural shapes shall be accurately shaped, at the shop, to conform to the section of the concrete floor. The fabrication and painting shall conform to the requirements of these specifications covering those items. When called for on the plans or in the special provisions the material shall be galvanized in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.

(d) Rubber Waterstops. Rubber waterstops shall be furnished and installed in accordance with the details shown on the plans and the following provisions.

Waterstops shall be either molded or extruded from plain or synthetic rubber, at the option of the contractor.

Plain rubber waterstops shall be manufactured from a stock composed of a high-grade compound made exclusively from new plantation rubber, reinforcing carbon black, zinc oxide, accelerators, anti-oxidants and softeners. This compound shall contain not less than seventy-two (72) percent by volume of new plantation rubber. The tensile strength shall not be less than three thousand five hundred (3500) pounds per square inch with an elongation at breaking of five hundred fifty (550) percent. The unit stresses producing three hundred (300) percent and five hundred (500) percent elongation shall not be less than one

thousand one hundred (1100) pounds and two thousand eight hundred (2800) pounds per square inch, respectively. The Shore Durometer indication (hardness) shall be between fifty-five (55) and sixty-five (65). After seven (7) days in air at 158° (±2°) F. or after four (4) days in oxygen at 158° (±2°) F. and three hundred (300) pounds per square inch pressure, the tensile strength and elongation shall not be less than sixty-five (65) percent of the original.

Synthetic rubber waterstops shall be manufactured from a compound made exclusively from neoprene or GRS, reinforcing carbon black, zinc oxide, polymerization agents, and softeners. This compound shall contain not less than seventy (70) percent by volume of neoprene or GRS. The tensile strength shall not be less than two thousand five hundred (2500) pounds per square inch with an elongation at breaking of four hundred twenty-five (425) percent. The Shore Durometer indication (hardness) shall be between fifty (50) and sixty (60). After seven (7) days in air at 158° (±2°) F. or after four (4) days in oxygen at 158° (±2°) F. and three hundred (300) pounds per square inch pressure, the tensile strength shall not be less than sixty-five (65) percent of the original.

The waterstops shall be molded or extruded with an integral cross-section and the section shall be uniform with a permissible variation in dimensions of ± one thirty-second (1/32) inch. No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured in a manner such that any cross-section shall be dense, homogeneous and free from all porosity. All junctions in the special connection pieces shall be full molded. During the vulcanizing period the joint shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross-section.

The molds may be of cast iron or mild steel, suitably constructed for continuous production, and the cavities may be unfinished, but reasonably smooth so as to produce a uniform section with a permissible variation in dimensions of ± one thirty-second (1/32) inch. The manufacturer may construct the molds in such a manner that by blanking in certain portions they may be used for the manufacture of other sections.

All field splices shall be full molded and splice faces shall be beveled at an angle of 45° or flatter. All finished splices shall have a tensile strength of not less than fifty (50) percent of the unspliced material.

45.16 Patching. The presence of excessive honeycombed areas shall be considered sufficient cause for the rejection of the structure, and upon written notice from the engineer, the contractor shall remove and rebuild the structure in part or in whole as specified, at his own expense. In patching holes or porous spots, all coarse or broken material shall be chipped away until a dense, uniform surface of concrete exposing solid coarse aggregate is obtained. Feather edges shall be cut away to form a face perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with thick, dry mortar composed of one part of Portland cement to three parts of sand, which shall be thoroughly tamped into place. The surface of this mortar shall be floated with a wooden float before the initial set takes place, and shall present a neat and workmanlike appearance of the same color as the remainder of the structure. The patch shall be kept continuously wet for a period of five (5) days. For patching large or deep areas, coarse aggregate shall be added to the patching material, if ordered by the engineer, and special precautions shall be taken to insure

a dense, well bonded and properly cured patch as required by the engineer.

45.17 Finishing. The following specifications set forth the requirements for the several classes of surface finish, which shall ordinarily be applied to the various parts of concrete structures.

Ordinary surface finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher class finish. On surfaces which are to be buried underground the removal of fins and form marks and the rubbing of mortared surfaces to a uniform color will not be required. Ordinary surface finish, unless otherwise specified, shall be considered as a final finish on the following surfaces:

(1) The undersurfaces of slab spans, box girders, filled spandrel arch spans, and floor slabs between T girders, of superstructures not for grade separation structures.

(2) The inside vertical surface of T girders, of superstructures not for grade separation structures.

(3) Surfaces which are to be buried underground or covered with fill. (4) The inside surfaces of Culverts

Class 1 surface finish shall be applied to the following surfaces unless otherwise specified in the special provisions, or shown on the plans.

(1) All surfaces of superstructures for grade separation structures.

(2) All surfaces above finished ground of bridge piers, columns and abutments, and retaining walls.

(3) The outside vertical surfaces and the under surfaces of cantilever floor slabs overhanging outside girders only, of superstructures not for grade separation structures.

(4) All surfaces of open spandrel arch rings, spandrel columns and abutment towers.

(5) Surfaces above finished ground of culvert headwalls and retaining walls, where visible from a traveled way.

Class 2 surface finish shall be applied to the following surfaces unless otherwise specified, or shown on the plans.

All surfaces of concrete rails, rail posts, rail end posts, rail base and curbs.

(1) Ordinary Surface Finish. During the pouring of concrete, care shall be taken that the methods of compaction used will result in a surface of even texture free from voids, water or air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface. Spades or broad-tined forks shall be provided and used if and as required by the engineer to produce the desired results.

Forms on all vertical faces which do not act as supporting members shall be removed as soon as practicable but not sooner than twenty-four

(24) hours after the concrete is poured. The engineer shall be the sole judge as to which parts of the forms are supporting members.

Immediately after the forms have been removed, all form bolts shall be removed to a depth of at least one (1) inch below the surface of the concrete. All holes and depressions caused by the removal of setting back of such form bolts shall be cleaned and filled with a cement mortar of matching color composed of one part by volume of cement to two parts of sand. Care shall be exercised to obtain a perfect bond with the concrete and after the cement mortar has thoroughly hardened, the surface shall be rubbed with a carbonrundum stone in order to obtain the same color in the mortar as in the surrounding concrete. All fins caused by form joints, and other projections shall be removed and all pockets cleaned and filled. Cement mortar for filling pockets shall be treated as specified for bolt holes. In the judgment of the engineer, if rock pockets are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of that portion of the structure affected.

(2) Class 1 Surface Finish. After completion of the ordinary surface finish, the entire surfaces specified shall be thoroughly brushed with stiff wire brushes. Brushing shall continue until a uniform color has been obtained. Use of carborundum stones may be required to remove unsightly bulges or discolorations.

The object of these operations is to obtain a smooth, even surface of uniform appearance and to remove unsightly bulges or depressions due to form marks and other imperfections. The degree of care in building forms and the character of material used in form work will be a contributing factor in the amount of such rubbing required, and the engineer shall be the sole judge in this respect. The wire brush finish shall not be applied until after the surfaces have been exposed to the elements for a period of not less than thirty (30) days, or until a uniform appearance to the surface can be secured. The intent of this specification is to secure a uniform appearing surface over the entire structure.

(3) Class 2 Surface Finish. When Class 2 surface finish is specified, the ordinary surface finish and Class 1 surface finish shall be completed in succession. The process specified under Class 2 surface finish shall then be deferred until all other work, which would in any way affect or mar the final finish, is complete. The contractor shall then apply a brush coat or surface film of thin cement mortar composed of one part Portland cement and one part of fine sand of such size that it will pass a No. 16 sieve, or at the option of the engineer, a neat cement wash. In either case an amount of calcium chloride equal to five (5) percent by volume of the cement shall be used in the brush coat.

When the cement film has set sufficiently so that the sand particles or cement will not drag out of surface pin holes, but before the final set has taken place, the entire surface shall be thoroughly rubbed either by hand or by mechanical means with fine carborundum stone (No. 25 to No. 30) until a smooth surface of even texture, color, and appearance is obtained. No greater amount of mortar shall be applied in advance of rubbing than can be completely rubbed before final setting takes place.

Immediately following the rubbing process the finished surface shall be thoroughly washed with water.

Rev.

45.18 Waterproofing. Concrete surfaces shall be waterproofed where and as designated on the plans.

45.19 Drainage and Weep Holes. Drainage and weep holes shall be constructed in the manner and where indicated on the plans or directed by the engineer. Drainage and weep holes in the faces of abutments shall be connected with roadway drains wherever indicated on the plans. Ports or vents for equalizing hydrostatic pressure shall be placed below low water. Weep holes shall be placed at the elevations shown on the plans or as directed by the engineer.

45.20 Live Loads. Live loads such as traffic or superimposed earth loads shall not be allowed on a structure until concrete has reached an age of twenty eight (28) days or until it has reached a strength of three thousand (3,000) pounds per square inch or the minimum ultimate strength shown on the plans.

45.21 Method of Measurement. The quantity to be paid for shall be the number of cubic yards of concrete, of the several classes, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing by the engineer. No measurements or other allowances will be made for work or material for forms, falsework, cofferdams, pumping, bracing, etc.

If the proposal contains such an item, concrete hand railing, including concrete posts, shall be measured in linear feet, in the completed and accepted work, in which case no allowance shall be made for the yardage contained in the railing.

45.22 Basis of Payment. The yardage, determined as provided above, shall be paid for at the contract unit price bid per cubic yard for "Class A concrete", "Class AA concrete", "Class B Concrete", Class BA Concrete", Class C Concrete", "Class CA Concrete", "Class D concrete", "Class DA Concrete", or "Cyclopean concrete" as the case may be. Concrete railing shall be paid for at the contract unit price bid per linear foot for "Concrete Rail". Such payment shall be full compensation for the concrete; for all materials including expansion joint filler, non-metallic drains, non-metallic waterstops, timber bumpers, forms, falsework, placing and finishing; and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the item. Reinforcing steel, including metal drains, metal waterstops, expansion joint angles, when there is no item for structural steel in the proposal, shall be measured and paid for as specified in Section 47.

SECTION 46 - WATERPROOFING AND DAMPPROOFING

46.1 Description. (a) Waterproofing shall consist of a firmly bonded membrane composed of two layers of saturated cotton fabric and three mop-pings of waterproofing asphalt together with a coating of primer applied to the surface of the concrete or other surface as shown on the plans.

(b)Dampproofing shall consist of two or more coats of asphalt for absorptive treatment applied to the surface of concrete or other surfaces as shown on the plans.

46.2 Materials. The materials furnished and used for this construction shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for class, type and grade of materials specified.

Specific reference to Part III "Material Details" is as follows:

Asphalt for Dampproofing and for Waterproofing. . . . . Section 95

Type A for above ground level and Type B for below ground.

Fabric shall conform to the requirements for "Woven Cloth Fabrics Saturated with Bituminous Substances for Use in Waterproofing" AASHO Desig-nation: M 117. The saturant shall be asphalt conforming to the cementing material.

Primer for use with asphalt in waterproofing below and above ground level shall conform to the requirements of "Primer for Use with Asphalt in Dampproofing and Waterproofing" AASHO Designation: M 116.

46.3 Application. All concrete surfaces which are to be waterproofed shall be reasonably smooth and free from holes and projections which might puncture the membrane. The surface to be waterproofed or dampproofed shall be dry and shall be thoroughly cleaned of dust and loose materials. No water-proofing or dampproofing shall be done in wet weather, nor when the temperature is below 65° F., without authorization in writing from the engineer.

(a) Waterproofing. Beginning at the low point of the surface to be waterproofed, a coating of primer shall be applied and allowed to dry before the first coat of asphalt is applied. The asphalt shall be heated to a temperature of not less than 300° F., nor more than 350° F., and thoroughly mopped onto the surface. A strip of fabric of half the width of the roll shall be rolled onto the hot asphalt immediately and carefully pressed into place so as to eliminate all air bubbles and obtain close conformity with the surface. This strip and an adjacent section of the surface of a width equal to slightly more than one-half the width of the fabric being used, shall then be mopped with hot asphalt and a full width of the fabric shall be rolled into this, completely covering the first strip and shall be pressed into place as before. This second strip and an adjacent section of the concrete surface shall then be mopped with hot asphalt and the third strip of fabric shingled on so as to lap the first strip by not less than two (2) inches. This process shall be continued until the entire surface is covered, each strip of fabric lapping at least two (2) inches over the last strip but one. The entire surface shall then be mopped with hot asphalt. The work shall be so regulated that at the close of the day's work the final mopping of asphalt shall have been applied to all the fabric

in place. Special care shall be taken at all laps to see that they are thoroughly sealed down.

(b) Dampproofing. Concrete or other surface which are to be dampproofed shall be thoroughly clean before the primer is applied. They shall then be brush or spray painted with two (2) or more coats of asphalt. First coat shall be applied at a rate of not less then one-eighth (1/8) gallon for each square yard of surface and the second or remaining coats at approximately one-tenth (1/10) gallon per square yard. Care shall be taken to confine all paint to the areas to be dampproofed and to prevent disfigurement of any other parts of the structure by dripping or spreading of the asphalt.

46.4 Method of Measurement. The quantity of membrane waterproofing to be paid for shall be the number of square feet in place in the completed and accepted work, measured in the plane of the surface waterproofed or dampproofed.

46.5 Basis of Payment. The quantity of membrane waterproofing or dampproofing measured as provided above, shall be paid for at the contract unit price bid per square foot for "Membrane Waterproofing" or "Dampproofing" as the case may be, which payment shall be full compensation for furnishing all labor, materials, tools, and equipment and for doing all the work involved in applying the membrane waterproofing, as shown on the plans and specified herein.

47.6 Mesh Reinforcement. Mesh reinforcement, when specified, shall conform to the requirements of Section 99 and shall be fabricated as shown on the plans.

47.7 Placing and Fastening. All bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete. When placed in the work, it shall be free from dirt, rust, mill scale, paint, oil, or other foreign material. Bars shall be tied at all intersections except where spacing is less than one (1) foot in each direction, when alternate intersections shall be tied.

Distances from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shape and dimensions or approved metal chairs. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks will not be permitted. Reinforcement in any member shall be placed, and then inspected and approved by the engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.

If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

47.8 Splicing. All reinforcement bars shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the engineer. Splices shall be staggered as far as possible. Unless otherwise shown on the plans, bars near the top of beams and girders having more than twelve (12) inches of concrete under the bars shall be lapped thirty-five (35) diameters and all other bars shall be lapped twenty (20) diameters to make the splice. In lapped splices, the bars shall be placed in contact and wired together. Welding of reinforcing steel shall be done only if detailed on the plans or authorized by the engineer in writing. Welding shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society.

Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one (1) mesh in width.

47.9 Substitutions. Substitution of different size bars will be permitted only with specific authorization by the engineer. If steel is substituted, it shall have an area equivalent to the design area or larger.

47.10 Method of Measurement. The quantity of bar reinforcing steel to be paid for shall be the total weight in pounds actually in place, as shown on the plans or revised by the authority of the engineer, based on calculated weights shown in the following table. The weight paid for shall not include the extra metal used when bars larger than those specified are substituted by permission of the engineer, the extra metal necessary for splices not indicated on the plans, nor weight of any device used to support or fasten the steel in its correct position. In the case of structures of reinforced

SECTION 47 - REINFORCING STEEL

47.1 Description. This item shall consist of furnishing and placing in concrete, reinforcing steel of the quality, type, size, and quantity designated, all as required by these specifications and as shown on the plans.

47.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Bar Reinforcement . . . . . Section 99
Mesh Reinforcement. . . . . Section 99

Bar reinforcement shall be deformed, and at the option of the contractor, shall be either intermediate grade or hard grade billet steel bars for concrete reinforcement. The various grades shall not be used interchangeably in structures.

47.3 Bending Diagrams. When required by the special provisions, order lists and bending diagrams shall be furnished by the contractor for approval by the engineer, and no material shall be shipped until such lists and bending diagrams have been approved. The approval of order lists and bending diagrams by the engineer shall in no way relieve the contractor of responsibility for the correctness of such lists and diagrams. Any expenses incident to the revision of materials furnished to make them comply with the design drawings shall be borne by the contractor.

47.4 Protection of Material. Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil, or other foreign substances. However, when steel has on its surface, rust, loose mill scale, or dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the engineer.

47.5 Fabrication. Bent bar reinforcement shall be cold bent to the shape shown on the plans; and, unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the following requirements:

Stirrups and tie bars shall be bent around a pin having a diameter not less than two times the minimum thickness of bar. Bends for other bars shall be made around a pin having a diameter not less than six times the minimum thickness, except that for bars larger than one (1) inch the bend shall be made around a pin of eight bar diameters.

Unless otherwise authorized by the engineer, reinforcing bars shall be cut and bent at the mill or shop before shipment to the work. Bending in the field will not be permitted except to correct errors, deformations due to handling, or minor omissions in shop fabrication.

Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the "Manual of Recommended Practice for Detailing Reinforced Concrete Highway Structures of the American Association of State Highway Officials."

concrete where there is no proposal item for structural steel, such minor metal parts as expansion joints, bolts, drains, and the like shall, unless otherwise specified, be measured as reinforcement.

If such an item is shown in the proposal form, the quantity of mesh reinforcement to be paid for shall be the number of square yards computed by multiplying the width of the section to be reinforced by its length. No allowance shall be made for laps.

The calculated weights of plain and deformed bars shall be based on the following table:

Size No.	Nominal Diameter In Inches	Weight Per Foot In Pounds
2	0.250	0.167
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.00	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313

47.11 Basis of Payment. Reinforcing steel, measured as provided above, shall be paid for at the contract unit price bid per pound for "Reinforcing Steel", which price shall be payment in full for furnishing the fabricated and bent material, placing, material used for fastening the steel in place, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the installation of the steel in the structure, as specified herein and as shown on the plans.

If such an item is provided in the proposal form, mesh reinforcement shall be paid for at the contract unit price bid per square yard for "Mesh Reinforcement", which price shall be full compensation for furnishing the mesh, placing, material used for fastening mesh in place, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the installation of the mesh.

SECTION 48 - STEEL STRUCTURES

48.1 Description. This item shall consist of furnishing, fabricating, casting, machining, or otherwise preparing, transporting, erecting, and painting any or all structural steel, rivet and eyebar steel, steel forgings, castings, and any other metal of the type, shape, dimensions and quality, required by these specifications or as shown on the plans.

48.2 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform with all the requirements for such materials as set out in Part III, "Material Details". Specific references to Part III are as follows:

High Tensile Strength Bolts	Section 97
Structural carbon steel	Section 97
Structural alloy steel	Section 97
Structural rivet steel	Section 97
Steel castings	Section 98
Gray iron castings	Section 98
Malleable iron castings	Section 98
Wrought iron	Section 98
Bronze castings	Section 98
Sheet copper	Section 98
Welding materials	Section 98

Turned bolts shall meet the material specification set forth by Structural Rivet Steel.

Ribbed bolts shall be of carbon manganese steel having a minimum ultimate tensile strength of seventy thousand (70,000) pounds per square inch.

FABRICATION

48.3 General Requirements. It is understood that the work to be done under these items includes everything which might reasonably be considered necessary for a complete workmanlike job in accordance with the plans and contract.

Workmanship and finish shall be equal to the best general practice in modern bridge shops. Portion of the work exposed to view shall be finished neatly. Shearing, plain cutting, and chipping shall be done carefully and accurately.

48.4 Shop Drawings. Shop drawings shall consist of shop detail, erection and other working plans showing dimensions, sizes of material, details and other information necessary for the complete fabrication and erection of the metal work. The drawings shall be prepared on sheets twenty-two (22) inches wide by thirty-six (36) inches. The original drawings may be made either on paper or on cloth, but the details must be drawn so that the prints will be clear and legible.

Unless otherwise requested, the contractor shall submit to the engineer for approval two (2) sets of checked shop drawings. The engineer reserves the right to refuse prints of shop drawings which are not clear and legible. Upon approval the contractor shall furnish the engineer with four (4) sets of shop drawings and the original tracings or Van Dyke negatives thereof. All shop plans shall be submitted for appro-

val at least fifteen (15) days before fabrication is started and no material shall be fabricated until the plans have been finally approved by the engineer. The shop drawings as approved by the engineer shall become a part of the contract; provided, however, that any substitution of sections contemplated by the shop drawings different from sections shown on the plans shall be made only when approved by the engineer and in such case additional cost resulting from such substitution shall be borne by the contractor.

After approval there shall be no deviation from the shop drawings or changes made thereon without the prior approval of the engineer.

Approval of shop drawings shall be understood to be an acceptance of the character and sufficiency of the details and not a check of any dimensions. Checking shop drawings is intended as a means of facilitating the work and avoiding errors so far as possible, but it is expressly understood that it will not relieve the contractor from responsibility in regard to errors or omissions on said shop drawings.

The contract price shall include the cost of furnishing all shop drawings and the contractor will be allowed no extra compensation for such drawings.

48.5 Notice of Beginning Work. The contractor shall give the engineer ample notice of the beginning of work at the mill or in the shop so that inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. No material shall be manufactured or work done in the shop before the engineer has authorized the fabrication. Any purchase of material prior to fabrication authorization shall be at the contractor's risk.

48.6 Inspection and Testing. The contractor shall furnish test specimens as required free of charge.

The contractor will require the fabricator of structural carbon steel or structural alloy steel to furnish the engineer with two (2) certified copies of mill inspection and test report showing both physical and chemical tests of each heat from which material is to be used.

All structural steel and miscellaneous metals described in Articles 48.1 and 48.2 shall be subject to shop inspection by the engineer, at his option.

The contractor shall furnish facilities for the inspection of material or workmanship in the shop and the inspector shall be allowed free access to the necessary parts of the work.

The inspector shall have the authority to reject any material or workmanship which does not meet the requirements of the specifications.

The acceptance of any material or finished members by the inspector shall not be a bar to their subsequent rejection if found defective.

Inspection at the shop is intended as a means of facilitating the work and avoiding errors so far as possible, but it is expressly understood that it will not relieve the contractor from responsibility in regard to imperfect material or workmanship or the necessity for replacing the same.

The contractor shall furnish the engineer with three (3) copies of mill orders and shipping statements. The weights of the individual members shall be shown on the statements.

48.7 Storage. Structural material, either plain or fabricated, shall be stored at the bridge shop above the ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter and shall be protected as far practicable from corrosion.

48.8 Straightening. Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends will be cause for rejection of the material.

48.9 Rivet Holes. Rivet holes in carbon steel which is more than three-quarter (3/4) inch in thickness shall be subpunched and reamed, subdrilled and reamed or drilled full size from the solid. Unless otherwise specified, all rivet holes in such material which is three-quarter (3/4) inch or less in thickness may be punched full size except where such holes match holes in thicker adjacent material. In such cases the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Rivet holes in material of alloy steel which is more than five-eighths (5/8) inches in thickness shall be subpunched and reamed, subdrilled and reamed or drilled full size from the solid. Unless otherwise specified, all rivet holes in such material which is five-eighths (5/8) inches or less in thickness may be punched full size except where such holes match holes in thicker adjacent material. In such cases the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Where there are five (5) or more thicknesses of metal, all holes regardless of the thicknesses of the separate pieces shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.

Full sized punched holes shall be one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. The diameter of the die shall not exceed the diameter of the punch by more than one-sixteenth (1/16) inch. If any holes must be enlarged to admit the rivets, they shall be reamed. Holes must be clean cut, without torn or ragged edges. Poor matching or mispunched holes will be caused for rejection.

Subpunched (or subdrilled) and reamed holes shall be punched or drilled not less than three-sixteenth (3/16) inch smaller than the nominal diameter of the rivet. After punching or drilling, the holes shall be reamed to a diameter of one-sixteenth (1/16) inch larger than the nominal diameter of the rivet. The punch and die shall have the same relative sizes as specified for full sized punched holes. Reamed holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by mechanical means. Burrs on the outside surfaces shall be removed. Poor matching of holes will be cause for rejection. Reaming of rivet holes shall be done with twist drills or with short taper reamers.

Full size drill holes shall be one-sixteenth (1/16) inch larger than the

nominal diameter of the rivet. Burrs on the outside surfaces shall be removed.

All holes punched full size, subpunched or subdrilled shall be so accurately punched after assembly (before any reaming is done) a cylindrical pin one-eighth (1/8) inch smaller in diameter than the nominal size in the punched hole may be entered perpendicular to the face of the member, without drifting, in at least seventy-five (75) percent of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces shall be rejected.

When holes are reamed or drilled eighty-five (85) percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than one thirty-second (1/32) inch between adjacent thicknesses of metal.

48.10 Subpunching, Drilling, Reaming and Shop Assembly. Unless otherwise specified, rivet holes and connections and splices (shop and field) of main truss or arch members, continuous beams, plate girders, and rigid frames and rivet holes in plate girder flanges, and stiffeners, intermediate stiffeners intended as supports for concentrated loads and web splices shall either be subpunched (or subdrilled) and reamed while shop assembled or drilled to full size from the solid while assembled at the shop. The assembly, including camber, alignment, accuracy of holes and mill joints, shall be approved by the engineer before reaming is commenced.

Unless otherwise specified, each individual (full length) truss, arch, continuous beam, or girder shall be assembled at the shop before reaming or drilling is commenced. During shop assembly all members shall be supported at such intervals and in such manner as is necessary to avoid undesirable deflections.

All holes for floor beam and stringer field end connections shall be subpunched and reamed to a steel template.

48.11 Shop Assembly. Shop assembly of trusses, arches, continuous beams, continuous plate girders, plate girders, and rigid frames shall be according to Article 48.10. All members shall be match marked before being disassembled.

Complete shop assembly of an entire structure, including floor system, which may be necessary in the case of complicated design or of skewed or super-elevated structure shall be done only if required by the special provisions.

The several component parts of a built-up member shall be straight and close fitting.

Surfaces of metal in contact shall be cleaned before assembling. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before drilling, reaming, or riveting is commenced. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operation. The member shall be free from twists, bends and other deformations.

Preparatory to shop riveting of full-size punched material, the rivet holes shall be cleared for the admission of the rivets by reaming.

End connections, angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped or otherwise firmly held in place until riveted.

The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

Parts not completely riveted in the shop shall be secured by bolts insofar as practicable to prevent damage in shipment and handling.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked, and a diagram showing such marks shall be furnished to the engineer.

48.12 Rivets. The size of rivets called for on the plans shall be the size before heating.

Rivet heads shall be of standard shape, unless otherwise specified, and of uniform size for the same diameter of rivet. They shall be full, neatly made, concentric with rivet holes, and in full contact with the surface of the member.

Field rivets shall be furnished in excess of the nominal number required to the amount of ten (10) percent plus ten (10) rivets for each diameter and length.

48.13 Shop Riveting. Rivets shall be heated uniformly to a "light cherry red color" and shall be driven while hot. Any rivet whose point is heated more than the remainder shall not be driven. When a rivet is ready for driving, it shall be free from slag, scale, or other adhering matter. Any rivet which, in the opinion of the engineer, is scaled excessively, shall be rejected.

All rivets that are loose, burned, badly formed, or otherwise defective shall be removed and replaced with satisfactory rivets. Any rivet whose head is deficient in size or whose head is driven off center will be considered defective and shall be removed. Stitch rivets that are loosened by the driving of adjacent rivets shall be removed and replaced with satisfactory rivets. Caulking or recupping of rivet heads will not be permitted.

Shop rivets shall be driven by direct-acting rivet machines where practicable. Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces. When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used. Pneumatic bucking tools will be required, when in the opinion of the engineer, the size and length of the rivets warrant their use.

Rivets may be driven cold provided their diameter is not over three-eights (3/8) inch.

48.14 Bolts and Bolted Connections. (a) General. Bolted connections shall not be used unless called for on the plans or in the special provisions. Where bolted connections are permitted, the bolts furnished shall be unfinished bolts, high-tensile bolts or ribbed bolts as specified. Ribbed high-tensile bolts may be substituted for field rivets in locations where, in the opinion of the engineer, it is impractical to drive rivets. Bolts shall be of such length that they will extend entirely through the nut, but not more than three-eights (3/8) inch beyond. The contractor shall furnish sufficient bolts of each type for each size and

length to bolt such connections as called for with an ample surplus to replace those lost or rejected.

The holes shall be truly cylindrical. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. Bolts shall be driven accurately into the holes without damaging the thread. A snap shall be used to prevent damaging the heads.

(b) Unfinished Bolts. Unfinished bolts shall be standard bolts with hexagonal heads and nuts. The diameter of the bolt holes will be one-sixteenth (1/16) inch greater than the diameter of the bolt. Threads on unfinished bolts shall be outside the grip and lock washers placed under the nuts of such bolts. Number of bolts furnished shall be five (5) percent more than the actual number shown on the plans for each size and length.

(c) High-Tensile-Strength Bolts. The assembly of structural connections using high-tensile-strength bolts and nuts with hardened washers where the initial tension in the bolt produces friction on the contact surfaces of the connected pieces sufficient in magnitude to resist shear shall conform to the following:

High-tensile-strength bolts may be substituted for rivets as indicated by the plans or special provisions.

Except as otherwise provided in this article, construction shall conform to applicable specifications for riveted structures.

Bolt lengths shall be determined by adding the values given in Table I to the total thickness of connected material. The values in Table I compensate for thickness of nut, two flat washers, and bolt point. The total length shall be adjusted to the next one-quarter (1/4) inch increment up to five (5) inch length and to the next longer one-half (1/2) inch increment for lengths over five (5) inches.

TABLE I--BOLT LENGTHS

Bolt Size (In.)	Add to Grip (In.)
1/2	1
5/8	1-1/8
3/4	1-1/4
7/8	1-1/2
1	1-5/8
1-1/8	1-3/4
1-1/4	1-7/8

If other than the standard thickness of circular washer as given in Table II is used, the necessary bolt length shall be adjusted accordingly. Where beveled washers of the dimensions given in Table II are used, an additional one-eighth (1/8) inch shall be added for each such beveled washer.

TABLE II--WASHER DIMENSIONS

Circular Washers				Square Beveled Washers For American Standard Beams and Channels			
Thickness Gage No.	Outside Diameter (In.)	Inside Diameter (In.)	Bolt Size (In.)	Inside Diameter (In.)	Width (In.)	Mean Thickness	Slope
12	1-3/8	9/16	1/2	9/16	1-3/4	5/16	1:6
10	1-3/4	11/16	5/8	11/16	1-3/4	5/16	1:6
9	2	13/16	3/4	13/16	1-3/4	5/16	1:6
8	2-1/4	15/16	7/8	15/16	1-3/4	5/16	1:6
8	2-1/2	1-1/16	1	1-1/16	1-3/4	5/16	1:6
8	2-3/4	1-1/4	1-1/8	1-1/4	2-1/4	5/16	1:6
8	3	1-3/8	1-1/4	1-3/8	2-1/4	5/16	1:6

Circular washers shall be flat and smooth and their dimensions shall be not less than would conform to the current requirements of the American Standards Association (ASA Designation: B27.2) as given in Table II. Where clearance is necessary, washers may be clipped on one side to a point not closer than seven-eighths of the bolt diameter from the center of the washer. Where bearing faces of the bolted parts have a slope of more than 1:20 with respect to a plane normal to the bolt axis, smooth beveled washers shall be used to compensate for lack of parallelism.

Bolt dimensions shall conform to the current requirements for "Regular Semi-Finished Hexagon Bolt" of the American Standards Association", ASA Designation: B18.2.

Nut dimensions shall conform to the current requirements for Heavy Semi-Finished Hexagon Nuts of the American Standards Association (ASA Designation: B18.2.).

Holes may be punched, subpunched and reamed or drilled, as required by the applicable specifications for riveted construction, and shall be of a diameter not more than one-sixteenth (1/16) inch in excess of the nominal bolt diameter.

Bolted parts shall fit solidly together when assembled. Contact surfaces, including those adjacent to the washers, shall be descaled or carry the normal tight mill scale. Contact surfaces shall be free of dirt, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts.

Contact surfaces of joints shall be free of paint or lacquer unless otherwise indicated by the plans or special provisions.

Connections shall be assembled with a hardened washer under the bolt head and nut. Surfaces of bolted parts in contact with the bolt head and nut shall be parallel, except flat washers may be used on surfaces having a slope not greater than 1:20 with respect to a plane normal to the bolt axis, provided the nut is torqued against a non-sloping surface. For slopes greater than 1:20, smooth beveled washers shall be used to produce parallelism.

All nuts shall be tightened to give at least the required minimum bolt tension values given in Table III upon completion of the joint.

TABLE III--BOLT TENSION AND TORQUE VALUES

Bolt Size (In.)	Recommended* Bolt Tension For Calibrating Wrenches (Lb.)	Required** Minimum Bolt Tension (Lb.)	Approximate*** Equivalent Torque For Required Minimum Bolt Tension (Lb.Ft.)
1/2	12,500	10,850	90
5/8	20,000	17,250	180
3/4	29,000	25,600	320
7/8	37,000	32,400	470
1	49,000	42,500	710
1-1/8	58,000	50,800	960
1-1/4	74,000	64,500	1,350

*Approximately 15 percent in excess of the Required Minimum Bolt Tension

**Equal to 90 percent of the minimum Proof Load of Bolt (ASTM A325). There is no recommended maximum bolt tension.

***Equal to 0.0167 lb. ft. per in. bolt diameter per lb. tension for nonlubricated bolts and nuts. Values given are experimental approximations. If torque rather than tension is to be measured, the torque-tension ratio shall be determined by the actual conditions of the application.

Note 1 - Wrenches should be set to induce a bolt tension in excess of the Required Minimum Bolt Tension as given in Table III. Because of the varying relation between torque and induced tension, it is suggested that wrenches be set to induce the Recommended Bolt Tension for Calibrating Wrenches as given in Table III.

Note 2- In using a power wrench, the recommendations of the wrench manufacturer should be consulted in its operation and care should be taken that the machine is maintained in proper working condition and proper calibration.

Note 3 - In using a manual torque wrench, the required torque can be read from the wrench dial, or in other types of wrenches, the torque may be indicated by a release of the wrench. Care should be taken that the wrench is properly calibrated. Nuts shall be in motion when torque is measured.

Note 4 - In using manual plain wrenches, a ratchet wrench of length consistent with the man-effort available should be used so that the product of the effective wrench length in feet times the man-effort in pounds exceeds the equivalent torque required.

As an alternate method of insuring the required minimum tension the one-turn-of-the-nut method may be used. The nuts shall be run up on the bolts to a "finger-tight" position by means of hand turning only (no spud wrench). From this commencing position, the nut shall be given one turn with the wrench. The turning can be controlled by means of a permanent mark or protrusion on the chuck of a pneumatic wrench.

In using this method it is essential to commence the tightening operation from a tightly fitted joint. Where this cannot be effected with ordinary erection bolts, the joint shall be brought to a tight fit by preliminary tightening of a few of the high-tensile bolts which must be marked for identification and release after the other bolts have been tightened.

In order to finish the connection, the high-tensile bolts used for the preliminary tightening of the joint, if any, shall be released, set at the finger-tight position and given one turn.

When breakages occur for bolts having short grips using this method, the amount of turn may be reduced on the basis of tests with a torque wrench.

(d) Ribbed Bolts. Ribbed bolts shall have button heads and either standard hexagonal nuts with lock washers or automatic or self-looking hexagonal nuts, together with such washers as are necessary. During erection all parts shall be drawn together tightly with erection bolts before ribbed bolts are inserted in the holes. Heads and nuts shall be drawn tight against the work. Bolt heads shall be tapped with a hammer while nut is being tightened. Ribbed bolts shall be driven entirely through the holes before the nuts are placed. A set, cupped to fit the head of the bolt, shall be used in driving. Where bolts are used on beveled surfaces, beveled washers shall be provided to give full bearing to the head and nut.

Holes for ribbed bolts which carry calculated load shall have a diameter which is one-sixteenth (1/16) inch greater than the nominal diameter of the bolt, shall be truly cylindrical and shall be subpunched (or subdrilled) and reamed while assembled, drilled from the solid while assembled or subpunched in only one thickness and the remaining thickness drilled from the solid while assembled. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal. If holes are finished in the shop, all parts shall be match-marked. Bolts shall be driven carefully into the holes without damaging either the head or the thread. Bolts shall have a driving fit.

Holes for ribbed bolts which do not carry calculated load shall meet the above requirements except that they may be punched or drilled full size.

Bolts shall be furnished in sufficient variety of length to comply with the recommendation of the manufacturer of the type bolt used for the thickness of metal involved. Ribbed bolts shall be furnished in the same number and in nominal sizes not smaller than the rivets for which they are substituted.

48.15 Edge Planing. Sheared edges of plates more than five-eighths (5/8) inch in thickness and carrying calculated stress shall be planed to a depth of one-quarter (1/4) inch. One-quarter (1/4) inch re-entrant cuts shall be filleted before cutting.

48.16 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the American Standards Association surface roughness requirements as defined in ASA B46.1-47, Surface Roughness, Waviness and Lay, Part I:

Steel slabs	ASA 2,000
Heavy plates in contact in shoes to be welded	ASA 1,000

Milled ends of compression members, stiffeners, and fillers	ASA	500
Bridge rollers and rockers	ASA	250
Pins and pin holes	ASA	125
Sliding bearings	ASA	125

Surfaces of bronze bearing plates intended for sliding contact shall be polished finished.

48.17 Abutting Joints. Abutting joints in compression members of trusses and in columns shall be milled.

Openings and abutting joints in tension members shall not exceed one-quarter (1/4) inch.

Abutting joints of continuous I beam spans shall be square and tight fit.

Abutting joints in top and bottom flanges of plate girders shall be square and tight fit.

48.18 Flame Cutting. Wrought-iron or carbon steel may be flame cut, provided a smooth surface is secured by the use of a mechanical guide. Flame cutting by hand shall be done only where approved by the engineer and the surface shall be made smooth by planing, chipping, or grinding. The cutting flame shall be so adjusted and manipulated as to avoid cutting beyond the prescribed lines. Re-entrant cuts shall be filleted to a radius of not less than one-half (1/2) inch.

In the case of alloy steel flame cut edges shall be removed to a depth of at least one-quarter (1/4) inch by milling, chipping, or grinding, except that machine flame cut edges may be used without such removal of metal if the edges are softened after cutting by heating the cut edge uniformly and progressively to a red heat visible in ordinary shop light (1150°F. to 1250°F.) to a depth of at least one-sixteenth (1/16) inch.

48.19 End Connection Angles. Floor beams, stringers, and girders having end connection angles shall be built to exact back to back of connection angles. If end connections are faced, the finished thickness of the angles shall not be less than that shown on the detailed drawings.

48.20 Lacing Bars. The ends of lacing bars shall be neatly rounded unless another form is required.

48.21 Web Plates. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than one-eighth (1/8) inch below at any point. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles. Web plates of girders having cover plates may be one-half (1/2) inch less in width than the distance back to back of flange angles.

Splices in webs of girders without cover plates shall be sealed on the top by welding.

At web splices, the clearance between the ends of the web plates shall not exceed three-eights (3/8) inch. The clearance at the top and bottom ends of web splice plates shall not exceed one-quarter (1/4) inch.

48.22 Welding. Welding of steel structures when authorized in accordance with the provisions contained herein, called for on the plans or in the special provisions, or upon written permission from the engineer shall conform to the requirements of the current specifications for "Welding Highway and Railway Bridges of the American Welding Society."

After cleaning and inspecting and within twenty-four (24) hours after depositing, welds shall be spot painted with a paint conforming to pertinent provisions of the paint specifications. Welds shall be flushed thoroughly with clean water to remove any alkaline residue and the flushed surface allowed to become dry before paint application.

Qualification of welders will be required. If no welding splices of main stress carrying members are involved, the tests will consist of the performance of a few sample welds by the welder and the factor and visual inspection thereof by the engineer. If splices of main stress carrying members are involved, qualification procedure shall conform to the latest "Specifications for Welded Highway and Railway Bridges," published by the American Welding Society. The expense of qualification tests shall be borne by the contractor.

48.23 Fit of Stiffeners. End Stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. Intermediate stiffener angles shall fit sufficiently tight to exclude water after being painted. Fillers under stiffeners shall fit within one-quarter (1/4) inch at each end.

Welding will be permitted in lieu of milling or grinding, if noted on the plans or specified in the special provisions.

48.24 Eyebars. Eyebars shall be straight, true to size, and free from twists, folds in the neck and head, and other defects. The heads shall be made by upsetting and rolling or forging, and not by welding. The form of the heads will be determined by the dies in use at the works where the eyebars are made, if they are satisfactory to the engineer. The thickness of the head and neck shall not overrun more than one-sixteenth (1/16) inch.

Eyebars that are to be placed side by side in the structure shall be bored so accurately that upon being placed together, pins one thirty-second (1/32) inch less in diameter than the pin holes will pass through the holes at both ends at the same time without driving.

48.25 Annealing and Stress Relieving. Members, such as bridge shoes, pedestals, or other parts which are built up by welding sections of plate together, shall be stress relieved in accordance with the provisions of the American Welding Society.

48.26 Pins, Rollers and Pin Holes. Rollers shall be of structural carbon steel. Pins shall be of carbon steel forgings. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth and free from flaws. Final surface shall be produced by a finishing cut.

Pins and rollers more than seven (7) inches in diameter shall be forged and annealed or cold finished carbon-steel shafting. In pins larger than nine (9) inches in diameter, a hole not less than two (2) inches in diameter shall be bored full length along the axis after the forging has been cooled to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.

Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required.

The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than one thirty-second (1/32) inch. Boring of holes in built-up members shall be done after the riveting is completed.

The diameter of the pin hole shall not exceed that of the pin by more than one-fiftieth (1/50) inch for pins five (5) inches or less in diameter, or more than one thirty-second (1/32) inch for larger pins.

Screw threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that pin ends having a diameter of one and three-eights (1-3/8) inches or more shall be threaded six (6) threads to the inch.

Pilot and driving nuts shall be used in driving pins. They shall be furnished by the contractor without charge. Two pilot nuts and two drifting nuts for each size of pin shall be furnished, unless otherwise specified. Pins shall be so driven that the members will take full bearing on them. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

48.27 Shop Painting. Unless otherwise provided, the application of shop paints shall conform to the requirements of Section 51, "Painting."

Surfaces to be in contact after shop riveting is completed shall be cleaned but shall not be painted.

48.28 Marking and Shipping. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon. Members weighing more than three (3) tons shall have the weight marked thereon. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged. All girders must be shipped in a standing position which position shall be maintained in subsequent operations.

Bolts and rivets of one length and diameter and loose nuts or washers of each size shall be packed separately. Pins, small parts and packages of bolts, rivets, washers and nuts shall be shipped in boxes, crates, kegs or barrels, but the gross weight of any package shall not exceed three hundred (300) pounds. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

Anchor bolts, washers, and other anchorage or grillage materials shall be shipped in time to suit the requirements of masonry construction.

ERECTION

48.29 Methods and Equipment. Before starting work, the contractor shall inform the engineer fully as to the method of erection he proposes to follow and as to the amount and character of the equipment he proposes to use, the adequacy of which shall be subject to the approval of the engineer. The approval of the engineer shall not be considered as relieving the contractor of the responsibility for the

safety and adequacy of his methods or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the engineer.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while riveting will not be permitted.

All work of erection shall be subject to inspection and the contractor shall furnish facilities for such inspection of material and workmanship. Material and workmanship not previously inspected shall be inspected after its delivery to the site of the work.

The contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting up bolts necessary for the expeditious handling of the work.

48.30 Handling and Storing. Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members such as columns and chords shall be supported on skids placed near enough together to prevent injury from deflection. All materials shall be handled in such a manner that no injury shall result. The contractor shall be responsible for the loss of any material while in his care or for any damage caused to it after being received by him.

48.31 Falsework. The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The contractor shall prepare and submit to the engineer, for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. Approval of the contractor's plans shall not be considered as relieving the contractor of any responsibility.

Upon completion of the erection and before final acceptance, the contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings replace or renew any fences damaged, restore in an acceptable manner all property both public and private, which may have been damaged during the prosecution of the work, and leave the structures site and adjacent highway in a neat and presentable condition satisfactory to the engineer.

All excavated material or falsework placed in the stream channel before construction shall be removed by the contractor before final acceptance.

48.32 Bearing and Anchorage. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise directed by the engineer, they shall be placed on a layer of canvas and red lead applied as follows:

> Thoroughly swab the bridge seat bearing area with red lead paint and place upon it three layers of twelve (12) to fourteen (14) ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the superstructure shoes or pedestals in position while the paint is plastic. As an alternate to canvas and red lead, sheet lead may be used if called for on the plans.

The milled and finished surfaces of castings or bearing plates shall have the shop coat of tallow, white lead or oil removed immediately prior to placing in the structure. Surfaces designed for sliding movement, one upon the other, shall be given a field coat of graphite grease when placed in the structure.

The contractor shall drill the holes and set the anchor bolts, except where the holes are formed or the bolts are built into the masonry. The bolts shall be set accurately and fixed with Portland cement grout, completely filling the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit free movement of the span.

48.33 Field Assembling and Riveting. The parts shall be accurately assembled as shown on the plans and match-marks shall be followed. The material shall be carefully handled so that no part will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted and all other truss connections pinned and bolted. Rivets in splices of butt joints of compression members and rivets in railings and connections shall have one-half (1/2) of the pins filled with bolts and cylindrical erection pins (Half bolts and half pins) before riveting. Splices and connections carrying traffic during erection shall have three-quarters (3/4) of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be one thirty-second (1/32) inch larger.

Pneumatic hammers shall be used for field riveting. Cup-faced dollies fitting the head closely to insure good bearing shall be used. Connections shall be accurately and securely fitted up before the rivets are driven. Driftings shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal. Unclear holes shall be reamed or drilled. Rivets shall be heated uniformly to a light "cherry red" color and shall be driven while hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical concentric with the shank and shall have full bearing all around. They shall not be smaller than the heads of the shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Caulking or recupping will not be permitted. In removing rivets, the surrounding metal shall not be injured; if necessary, they shall be drilled out.

Field driven rivets shall be inspected and accepted before being painted.

48.34 Pin and Bolt Connections. Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members will take full bearing. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

In bolted connections the bolts shall be drawn up tight and the threads burred at the face of the nut with a pointed tool.

48.35 Misfits. The correction of minor misfits involving nonharmful amounts of reaming, cutting and chipping shall be considered a legitimate part of the erection. However, any error in the shop fabrication, or deformation resulting from handling and transportation, which prevents the proper assembling and fitting up of the parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the engineer and his approval of the method of correction obtained. The correction shall be made in his presence. The contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements.

48.36 Field Painting. Structural steel, unless otherwise specified shall be painted as specified in Section 51.

48.37 Method of Measurement. The quantity of structural steel to be paid for under this item shall be determined by scale weights, or if permitted by the engineer, by computed weights, obtained as hereinafter provided. Only material actually used in the completed structure will be paid for.

Computed weights shall be used to determine pay quantities of silicon and carbon steel when members contain both silicon and carbon steel.

The weight of erection bolts, field paint and all boxes and crates or other containers used for packing together with the materials used for supporting members during transportation will not be included in the weights of material to be paid for. For the purpose of measurement for payment, steel plate and shapes for pier protection, all metal conduits, scuppers, pipes and drains in the superstructure, and all zinc and other similar metals required in the substructure shall be considered as structural steel. Expansion plates and rockers or castings of any kind, regardless of the type of material specified, shall also be considered as structural steel.

The weight of structural steel to be paid for shall not exceed the computed weight by more than one and one-half (1-1/2) percent. The weight of cast steel, cast iron or cast bronze to be paid for shall not exceed the computed weights by more than seven and one-half (7-1/2) percent. If the scale weight of any member is less than ninety seven and one-half (97-1/2) percent of the computed weight of that member, the member will be rejected and will not be paid for.

Scale weight shall be the actual weight of the members as determined on accurate scales. Material weighed at the shop shall be weighed in the presence of the engineer. When carload or truck weights are used, a record shall be submitted to the engineer, which shall contain an itemized statement of the dunnage and the members included in each lot.

If computed weights are permitted, the weight to be paid for will be the calculated weight as established by the engineer and no allowance will be made in excess thereof.

The computed weight shall be obtained by the use of the following rules and assumptions:

The weight of structural and cast steel shall be assumed at four hundred ninety (490) pounds per cubic foot. The weight of cast iron shall be assumed at four hundred forty-five(445) pounds per cubic foot. The weight of bronze and cast bronze shall be assumed at five hundred thirty-six (536) pounds per cubic foot.

The weights of rolled shapes and of plates up to and including thirty-six (36) inches in width shall be computed on the basis of their nominal weights and dimensions as shown on the approved shop drawings, deducting for copes, cuts and all open holes, except rivet holes.

To the nominal weights of plates more than thirty-six (36) inches in width, there shall be added one-half of the allowed percentage of overrun in weight given in the current specification, ASTM Designation: A6

Since no deduction for rivet holes is made in the computed weight of structural steel members, the computed weights of the completed members will be obtained by adding to the above weights the weights of the heads of all rivets in the structure, both shop-driven and field-driven. Full compensation for all rivets furnished in excess of the actual number in place in the completed structure shall be considered as included in the price paid per pound for structural steel in place and no additional allowance will be made therefor. Should the computed weights be used to determine pay quantities, the weight of rivet heads shall be assumed as follows:

Diameter of Rivet	Weight of 100 Heads, Pounds
1/2 inch	4.0
5/8 inch	7.0
3/4 inch	12.0
7/8 inch	18.0
1 inch	26.0
1-1/8 inch	36.0
1-1/4 inch	48.0

The weight of castings shall be computed from the dimensions shown on the approved shop drawings, deducting for open holes. To this weight shall be added ten (10) percent allowance for fillets and overrun.

To the total computed weight of metal shall be added four-tenths (0.4) of one (1) percent as an allowance for shop paint.

Steel grid flooring shall be measured and paid for as structural steel only if so specified in the special provisions.

The weight of steel or brass shims required shall be included.

If the proposal contains such an item, structural steel railing shall be measured in linear feet between concrete posts in the completed and accepted work.

48.38 Basis of Payment. The weight determined as provided above shall be paid for at the contract unit price bid per pound for "Structural Steel", which payment shall include full compensation for furnishing labor, materials, tools, supplies and equipment and doing all the work involved in furnishing, fabricating, delivering, erecting and painting the steel work complete in place in accordance with the details shown on the plans and as herein specified, including furnishing of mill test reports and test specimens, except the specimens for full-size tests.

Full size eyebars which are tested and meet the requirements of these specifications shall be paid for at the same rate as for the structure. Bars which fail to meet these requirements, and all bars rejected as a result of tests, shall not be paid for. The physical requirements for full size tests shall be as specified in the Special Provisions.

If an item is shown in the proposal form, structural steel railing shall be paid for at the contract unit price per linear foot for "Structural Steel Rail, Type_____," which payments shall be full compensation for furnishing, fabricating, delivering, erecting, and painting, and all labor, materials, tools, supplies, equipment and incidentals necessary to complete the item, furnishing of mill test reports and test specimens, in accordance with the plans and these specifications.

SECTION 49 - TIMBER STRUCTURES

49.1 Description. This item shall consist of furnishing, framing and installation of timber of the kind, sizes and dimensions and in accordance with the lines, grades and sections shown on the plans.

49.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Structural, Rivet and Eyebar Steel	Section 97
Miscellaneous Metals	Section 98
Hardware	Section 100
Timber	Section 107
Timber Preservative	Section 109

49.3 Material Lists. If material lists or order lists are sent by the contractor to the engineer for checking or approval, such checking or approval by the engineer shall in no way relieve the contractor of responsibility for the correctness of such lists. Any expenses incident to the revision of materials furnished in accordance with such lists to make them comply with the design drawings shall be borne by the contractor.

49.4 Lumber Grades. All framing lumber and structural timber, unless otherwise specified or shown on the plans, shall be Douglas Fir or West Coast Hemlock or Larch, of the grades specified herein, in the special provisions or shown on the plans. Grading rules as hereinafter specified by paragraph numbers for convenience refer to "Standard Grading and Dressing Rules, No. 15," of the West Coast Lumbermens Association for Douglas Fir. Grading rules of other recognized associations as set forth in Section 107 shall apply equally.

Unless otherwise specified in the special provisions or shown on the plans the grades of timber and lumber shall conform to the following:

(a) Solid Timbers, 5" and Thicker, Rectangular:
"Dense Construction" - Beams and Stringers, 1750f - paragraph #124-bb.

(b) Solid Timbers, 5" x 5" and Larger:
"Construction" - Posts and Timbers, 1200c - paragraph #125-b.

(c) Framing, 2" to 4" Thick - 6" and Wider:
"Construction" - Joists and Planks, 1500f - paragraph #123-b.

(d) Light Framing, 2" to 4" Thick, 2" to 4" wide:
"Select Structural" - Light Framing, 1900f - paragraph #122-a.

(e) Boards, 1", 1-1/4", 1-1/2" Thick, 2" and Wider:
"Select Merchantable" - Boards - paragraph #120-a.

Only reasonably dry, well seasoned lumber will be accepted. All shall be AD or KD, in accordance with paragraph 2g and (bb).

49.5 Storage of Materials. Lumber and timber on the site of the work shall be stored in piles.

Untreated material shall be open-stacked at least twelve (12) inches above the ground surface and piled to shed water and prevent warping. When required by the engineer it shall be protected from the weather by suitable covering.

Treated timber and piling shall be close-stacked and piled to prevent warping, and the bottom of the piles shall be [illegible] two (2) [illegible].

The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish.

49.6 Workmanship. Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed, and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman causing them. The workmanship on all metal parts shall conform to the requirements specified in Section 48.

49.7 Treated Timber. Treated timber and piling shall be carefully handled without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools. It shall be handled with rope sling. Cant hooks, peaveys, pikes, or hooks shall not be used.

All cutting, framing, and boring of treated timbers shall be done before treatment, insofar as is practicable.

All cuts in treated piles or timbers, and all abrasions, after being carefully trimmed, shall be covered with two applications of a mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch or brush coated with at least two applications of hot creosote oil and covered with hot roofing pitch.

All bolt holes bored after treatment, shall be treated with creosote oil by means of an approved pressure bolt hole treater. Unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

Whenever, with the approval of the engineer, forms or temporary braces are attached to treated timber with nails or spikes, the holes shall be filled by driving galvanized nails or spikes flush with the surface or plugging holes as required for bolt holes.

49.8 Untreated Timber. In structures of untreated timber the following surfaces shall be thoroughly coated with two coats of hot creosote oil before assembling: ends, tops, and all contact surfaces of sills, caps, floors, and stringers; and all ends, joints, and all contact surfaces of bracing and truss members. The back faces of bulkheads and all other timber which is to be in contact with earth, metal, or other timber shall be similarly treated.

Unless untreated timber is to be used in the construction within three (3) days after date of delivery, it shall be painted on each end with a prime coat at time of delivery.

49.9 Holes for Bolts, Dowels, Rods, and Lag Screws. Holes for round drift-bolts and dowels shall be bored with a bit one-sixteenth (1/16) inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.

Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.

Holes for rods shall be bored with a bit one-sixteenth (1/16) inch greater in diameter than the rod.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

49.10 Bolts and Washers. A washer of the size and type specified, shall be used under all bolt heads and nuts which would otherwise come in contact with wood.

All bolts shall be effectively checked after the nuts have been finally tightened.

49.11 Countersinking. Countersinking shall be done whenever smooth faces are required. Horizontal recesses formed for countersinking shall be painted with hot creosote oil, and, after the bolts are screwed in place, shall be filled with hot pitch.

49.12 Framing. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surfaces. Mortises shall be true to size for their full depth and tenons shall fit snugly. No shimming will be permitted in making joints, nor will open joints be accepted.

49.12 Framed Bents. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of not less than three-quarters (3/4) inch diameter and projecting at least six (6) inches above the tops of the pedestals, shall be set in them when they are cast, for anchoring the sills or posts.

Sills shall have true and even bearing on mud sills, piles or pedestals They shall be drift-bolted to mud sills or piles with bolts of not less than three-quarters (3/4) inch diameter and extending into the mud sills or piles at least six (6) inches. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.

Posts shall be fastened to pedestals with dowels of not less than three-fourths (3/4) inch diameter, extending at least six (6) inches into the posts.

Posts shall be fastened to sills by one of the following methods, as indicated on the plans:

(a) By dowels of not less than three-fourths (3/4) inch diameter, extending at least six (6) inches into posts and sills.

(b) By drift-bolts of not less than three-fourths (3/4) inch diameter driven diagonally through the base of the post and extending at least nine (9) inches into the sill.

49.14 Caps. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift-bolts, as indicated on the plans, extending at least nine (9) inches into the posts or piles. Drift-bolts shall be approximately in the center of the post or pile.

49.15 Bracing. The ends of bracing shall be bolted through the pile, post, or cap with a bolt of not less than five-eights (5/8) inch diameter. Intermediate intersections shall be bolted, and spiked with wire or boat spikes, as indicated on the plans. In all cases spikes shall be used in addition to the bolts.

49.16 Stringers. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least one-half (1/2) inch for the circulation of air and shall be securely fastened by drift-bolts where specified. When stringers are two panels in length the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails at each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified in the contract, cross-bridging shall be placed at the center of each span.

49.17 Plank Floors. Unless otherwise specified, flooring plank shall be surfaced one side and one edge. Single plank floors shall consist of a single thickness of plank supported by stringers or joists. The plank shall be laid heart side down with one-quarter (1/4) inch openings between them for locally seasoned material and with tight joints for unseasoned material. Each plank shall be securely spiked to each joist. The plank shall be carefully graded as to thickness and so laid that no two adjacent planks will vary in thickness more than one-sixteenth (1/16) inch.

Two-ply timber plank floors shall consist of two layers of flooring supported on stringers or joists. The lower course shall be pressure-treated with a creosote oil. The top course may be laid either diagonal or parallel to the center line of the roadway, as specified, and each floor piece shall be securely fastened to the lower course. Joints shall be staggered at least three (3) feet. If the top flooring is placed parallel to the center line of

the roadway, special care shall be taken to securely fasten the ends of the flooring. At each end of the bridge these members shall be beveled.

49.18 Laminated Floors. Laminated floors shall be composed of three (3) by six (6) inch or two (2) by six (6) inch timbers, as indicated on the plans, laid on edge at right angles to the center line of the roadbed, unless otherwise shown on the plans.

The flooring may be of random length and multiples of the stringer spacing with no single piece less than six (6) feet long. All splices shall be made on the center line of a stringer and shall not occur oftener than once in six (6) inches on any one stringer.

Laminations shall be laid with a finished edge down. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than one-eighth (1/8) inch from a true plane, except treated stringers, shall be surfaced to meet this requirement. Treated stringers which do not meet the requirements may be rejected but shall not be framed or adzed after treatment. Each piece of flooring shall be fastened to the preceding strip at each end and at approximately eighteen (18) inch intervals with spikes or nails driven alternately near the top and bottom edges. Spikes or nails shall be of sufficient length to pass through two strips and at least half-way through the third strip. If timber supports are used, each piece shall be toe-nailed to every other support with 20d or 30d nails. Care shall be taken to have each strip vertical and tight against the preceding one, and bearing evenly on all supports.

49.19 Wheel Guards and Railing. Wheel guards and railing shall be accurately framed in accordance with the plans and erected true to line and grade. Unless otherwise specified, wheel guards shall be surfaced one side and one edge (S1S1E) and rails and rail posts shall be surfaced on four sides (S4S). Wheel guards shall be laid in sections not less than twelve (12) feet long.

49.20 Trusses. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection, and, in vertical projection, shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

Unless otherwise directed by the engineer, housings and railings shall be built after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

49.21 Painting. Outside stringers, wheelguards, rails, rail posts, and exposed surfaces of scupper blocks, filler blocks, and flooring of untreated timber, or timber treated with preservative salts, shall be painted with three coats of paint as specified in Section 51.

Ends of all pieces of untreated timber not otherwise painted shall be painted with one prime coat.

Metal parts, except hardware, shall be given one coat of shop paint, and, after erection, two coats of field paint, as specified in Section 51.

49.22 Method of Measurement. Timber and lumber shall be measured by the number of thousand feet, board measure, remaining in place in the completed and accepted structure, based on the nominal sizes and the shortest commercial length which could be used. No other allowance for waste will be made.

49.23 Basis of Payment. The quantity of timber and lumber, measured as provided above, shall be paid for at the contract unit price per thousand feet board measure for "Untreated Douglas Fir," "Treated Douglas Fir," "Redwood," "Port Orford Cedar," "Larch," or "West Coast Hemlock", as the case may be, complete in place. If such an item is shown in the proposal form, laminated timber culvert barrel shall be paid for at the contract unit price per linear foot for " _____ ft. X _____ ft. Laminated Culvert." Such payment shall be full compensation for furnishing all materials, including hardware, treating when specified, furnishing and applying paint, framing, erecting, and for all labor, material, tools, supplies, equipment, and incidentals necessary to complete the work. The contract price shall include the cost of furnishing inspection certificates. The cost of inspection of preservative treatment shall be borne by the department.

Metal parts, other than hardware shall be measured and paid for as specified in Section 48.

SECTION 50 - PILING

50.1 Description. This item shall consist of furnishing and driving bearing piles of the kind, shape and size called for on the plans or in the special provisions. It includes timber piles, precast or cast-in-place concrete piles and steel piles as described herein and is also applicable to other types of bearing piles if called for on the plans and in the special provisions.

Piles shall be driven in accordance with these specifications and in the location and manner and to the elevation shown on the plans or as directed by the engineer.

50.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Steel Piles (H-Bearing Piles)	Section 97
Reinforcement	Section 99
Timber Piles	Section 108

The materials for concrete shall conform to the requirements of Section 44.

Steel shells shall meet the requirements of the current "Standard Specifications for Welded and Seamless Steel Pipe Piles," ASTM Designation: A 252, Grade 2.

The contractor shall furnish the engineer with copies of mill test reports on the steel shells and H Bearing Piles.

50.3 Driving of Piles. Piles shall not be driven until after the excavation is completed. Any material forced up between the piles shall be removed to correct elevation before masonry for the foundation is placed.

Care shall be exercised to prevent damage to the piles due to overdriving.

Piles shall be driven battered (sloped) if and as called for on the plans.

All piles raised during the process of driving adjacent piles shall be driven down again. The driving equipment shall be in good operating condition.

The size of hammer shall be selected to suit the conditions that will be encountered. It shall neither be so small that its energy will be largely dissipated in lost energy during driving nor so great that it will cause too rapid penetration and damage to the pile. If the size of hammer used is found to be unsatisfactory, it shall be replaced with a larger or smaller hammer or other corrective measures shall be used as required to produce satisfactory results.

Timber Piling may be driven with either single or double acting steam or air hammers or with drop hammers, all other bearing piles shall be driven with either single or double acting steam or air hammers.

Precast concrete piles shall be driven with a steam or air hammer which shall develop an energy per blow at each full stroke of the piston of not less than one (1) foot-pound for each pound of weight driven. In no case shall the total energy developed by the hammer be less than six thousand (6000) foot-pounds per blow.

For cast-in-place concrete piles where a mandrel is used in driving the shell, the total weight of the mandrel and the shell shall be considered as the weight of the pile and the hammer shall meet the same requirements as for precast concrete piles.

Hammers for driving H-bearing steel piles and steel shells for cast-in-place concrete piles, which are driven without mandrel, shall be steam or air hammers of sufficient capacity to drive the pile or shell to the required penetration and bearing value without appreciable distortion or distress to the pile or shell.

Gravity hammers shall weigh not less than three thousand (3000) pounds and shall be equipped with proper leads and hoisting equipment to handle the work efficiently. The fall of the hammer shall not exceed ten (10) feet.

Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gage at all times. The valve mechanism and other parts of the steam or air hammer shall be maintained in first-class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained. Inefficient steam or air hammers shall be removed from the work. When necessary to obtain the necessary penetration, the contractor shall supply and operate at his own expense, single or double water jets and pumps, or furnish the necessary drilling apparatus and drill holes not greater than the diameter of the pile to the proper depth and drive the piles therein. If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing. Jets or drills may be used only for timber, precast or cast-in-place concrete piles, and only when so specified or ordered in writing by the engineer. The use of jets or predrilling for steel H-beam piles will not be permitted.

Driving leads shall be used and shall be constructed in such a manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or stiff braces to insure support to the pile during driving. Except where piles are driven through water, the leads, preferably, shall be of sufficient length so that the use of a follower will not be necessary.

Unless otherwise ordered inclined leads shall be used in driving battered piles.

The travel of the hammer shall be accurately in line with the axis of the pile. A cap device shall be used, fitted with sliding jaws to engage the leads, to guide the pile and to maintain its top in line with the stroke of the hammer. An adequate cushion cap shall be used in driving precast concrete piles and also in driving timber piles with a drop hammer or in other cases if the driving would cause damage to the top of the pile. The top of the pile and the cap shall be so shaped that the blow of the hammer will be uniformly distributed to the entire top surface of the pile.

The contractor shall make adequate advance preparation when it is necessary to splice a steel pile or the steel shell or casing of a cast-in-place concrete pile so as to reduce to a minimum the interuption of driving while the splice is being made.

When the depth of penetration will be affected by the results of testloading, piling shall not be driven until after the test-loading has been completed, except in case of service piles driven to serve as anchor piles for the test-loading.

If the top of a pile becomes broomed, split or crushed during the driving, the driving shall be stopped until the pile has been repaired or replaced by a new one.

The driving heads shall closely fit the top of the steel pile or shall extend down over the sides of the pile at least four (4) inches.

Piles shall be driven to the position and line indicated on the plans. Piles materially out of line shall be pulled and replaced.

50.4 Bearing Value and Penetration. Piles shall be driven to a bearing value of not less than the design loading shown on the plans, and in addition shall penetrate at least to the specified tip elevation shown on the plans at any location where a specified tip elevation is shown, unless otherwise permitted in writing by the engineer; or shall penetrate at least ten (10) feet into the natural ground when a tip elevation is not specified, unless a lesser penetration is approved by the engineer.

Natural ground in any area or highway embankment shall be defined as the bottom of the highway embankment.

When the pile design loading is omitted from the plans, timber, steel, and concrete piles shall be driven to bearing values equal to the "Maximum Design Loads for Piles," specified in the Standard Specifications for Highway Bridges of the AASHO. The bearing values for driven piles shall be determined from the following formula:

$$P = \frac{F\,E}{S + 0.1H}$$

P = safe bearing value in pounds.
E = the energy of the hammer blow in foot-pounds.

For drop hammers and single acting steam hammers E = WH, where W is the weight of the striking parts of the hammer in pounds, and H is the height of fall of the striking parts in feet.

For double acting or differential steam hammers E = the manufacturers rated energy in foot-pounds, and

$$H = \frac{E}{W}$$

S = the average penetration in inches per blow for the last 5 to 10 blows.

F is a factor which varies with the type of soil in which the pile is driven.

F = 2 for alluvial deposits, soft clays, or silts, or other soil of poor bearing value.

F = 2.5 for wet mixed clay and sand, tight clay, fine sand or sand and silt.

F = 3 for medium sand, moderately compact clayey sand or sand and gravel.

F = 4 for compact sand, or sand and gravel.

F = 4.5 for very compact sand or gravel.

When several kinds of soil are penetrated a weighted average value of F will be determined for the entire depth of penetration, giving more weight to the soil near the point than to that above.

The above formula is applicable only when:

(a) The hammer has a free fall.
(b) The head of pile is not damaged.
(c) The penetration is reasonably quick and uniform.
(d) A follower is not used.

Twice the height of bounce shall be deducted from "H" to determine its value in the formula.

In case jets are permitted in connection with the driving, the bearing power shall be determined by the above formula from results of driving after the jets have been withdrawn.

If the weight of pile and driving cap is greater than the weight of striking parts of the hammer, the formula shall be multiplied by the factor $\frac{2W}{W+P}$ where P = the weight of pile and cap.

Pins, brackets, plates or other devices such as may be required by the engineer to increase the bearing value of steel H-bearing piles, shall be provided by the contractor.

50.5 Cut-Off and Extension. Timber piles which are to be capped shall be accurately cut off so that true bearing is obtained on every pile without use of shims. Other timber piles shall be cut off on the square at the elevation designated. Piles inaccurately cut off shall be replaced. Splicing of timber piles will not be permitted except upon the written permission of the engineer. Concrete piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the plans. Concrete piles may be cast the full length of the reinforcing bars, providing that the concrete is cut off to expose the steel as shown on the plans after the piles have been driven. When it is necessary, after driving, to increase the length of precast concrete piles, concrete shall be removed to expose sufficient reinforcing steel to permit a lap of at least forty (40) diameters. The added length shall be sufficient to reach the elevation of the bottom of the cap and shall be of the same section and the same reinforcement as the pile itself.

When the cut off elevation for precast concrete pile is below the elevation of the bottom of the cap, the pile shall be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete extension constructed as shown on the plans.

The work of cutting off precast concrete piles shall be performed in such a manner as to avoid spalling or damaging the pile below the cutoff. In case of such damage the pile shall be replaced or repaired as required by the engineer.

Steel shells for cast-in-place concrete piles shall be cut off at the designated elevation before being filled with concrete.

Steel piles shall be cut off at the elevation designated and when shown on the plans shall be capped with steel plates or other devices.

The cut-off lengths of all timber and concrete piling, and all steel shells and steel H piling less than five (5) feet in length shall become the property of the contractor and shall be disposed of by him outside of the right-of-way. Cut-off lengths of Steel H piling and steel shells five(5) feet long or longer shall remain the property of the department. Compensation for stockpiling H pile and steel shell cut-offs five (5) feet or more in length, and for disposing of all other cut-offs as herein specified shall be considered as included in the contract prices paid for

furnishing piling and no additional allowance shall be made therefor.

The exposed portion of steel piles or the shell or casing of cast-in-place concrete piles shall be painted. Unless otherwise called for on the plans the paint shall be applied in the field and shall consist of a prime coat and two field coats as specified in Section 51.

50.6 Load Testing. The piles to be test loaded together with adjacent anchor piles shall be constructed for test load purposes as shown on the plans. They shall be carefully located in line and the butts of the piles in each group shall be constructed to the plane shown on the plans above the elevation of the bottom of the footing. The number of loading tests and the locations shall be as noted on the plans.

Load tests shall be applied in the manner shown on the plans and shall consist of the application of a test load by means of a one hundred (100) ton hydraulic jack, equipped with an accurate calibrated pressure gage reading in pounds per square inch or tons of total load, so arranged as to apply and maintain the required test load for a period of twenty-four (24) hours, or more, and equipped with a device for measurement of the settlement of the pile under each increment of load.

The test loads shall be applied in increments of ten (10) tons until a total load of twice the design bearing value has been reached. Two measurements of settlement shall be taken after each increment of load, one immediately after applying load and the other after the load has been maintained for ten (10) minutes. The total load shall be maintained for a period of twenty-four (24) hours, or a minimum of sixteen (16) hours provided no settlement has taken place in the last four (4) hours. If settlement continues for twenty-four (24) hours, the full load shall be maintained for an additional twenty-four (24) hours or until settlement ceases for a period of four (4) hours. The loads shall be reduced in decrements of ten (10) tons, measuring recovery after each decrement of load, until no load remains.

Another load shall then be applied in increments of ten (10) tons, taking two measurements of settlements after each increment of load as noted above until the maximum capacity of pile is reached or until the maximum capacity of the testing apparatus is reached. The load shall then be reduced in decrements of ten (10) tons, measuring the recovery after each decrement.

50.7 Timber Piles. The specie of timber used for timber piles shall be either Douglas Fir, Southern Yellow Pine, Larch or Cedar as shown on the plans or specified in the special provisions.

When treated piles are required they shall be given a preservative treatment of creosote by pressure processes as specified in Section 52.

Timber piles shall conform to the requirements of Section 108 and shall be inspected as therein provided.

Commercially treated piles from stock may be used for test piles when required. Where commercially treated piles are permitted, stamping the piles by the inspector before treatment will not be required.

Treated timber piles shall be carefully handled during and after unloading from cars. They shall not be dragged across the ground at any time and shall be handled only with rope slings or with wooden equipment. Sharp tools shall be permitted only when used for necessary field cutting and trimming. All places where the surface of creosoted piling is broken by cutting, boring or otherwise, shall be thoroughly coated with at least three applications of hot creosote oil. Each

application shall be allowed to become reasonably dry before the succeeding one is applied.

The piles in any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.

Heads of piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design.

The heads of all untreated Douglas fir, Larch, or southern yellow pine piles which are not under water shall be treated with two coats of hot creosote oil, after the piles have been driven and cut off to the proper elevation.

The heads of all treated Douglas fir, Larch or southern yellow pine piles shall be treated by one of the following methods after the piles have been driven and cut off to the proper elevation.

A coat of hot creosote oil shall first be applied to the head of the pile and a protective cap shall be built up by applying alternate layers of loosely woven fabric in hot asphalt or tar similar to membrane waterproofing, using three layers of asphalt or tar and two layers of fabric. The fabric shall measure at least six (6) inches more in each direction than the diameter of the pile and shall be turned over the pile and the edges secured by binding with two turns of No. 10 galvanized wire. The fabric shall be wired in advance of the application of the final coat of asphalt or tar which shall extend down over the wiring.

In lieu of the above method of treatment, the sawed surface may be covered with three applications of a hot mixture of sixty (60) percent creosote oil and forty (40) percent roofing pitch, or thoroughly brush coated with three applications of hot creosote oil and covered with hot roofing pitch. A covering of galvanized sheet iron shall be placed over the pitch coating and bent down over the sides of the pile to shed water.

The treatment of pile heads encased in concrete will not be required.

The method to be used shall be at the option of the contractor unless otherwise provided on the plans or in the special provisions.

50.8 Precast Concrete Piles. Precast concrete piles shall be constructed of Class A or AA, Portland Cement concrete proportioned and mixed in accordance with the requirements of Section 44 and placed in accordance with Section 45 of these specifications. Reinforcing steel shall conform to the requirements of Section 47 of these specifications.

Concrete for precast concrete piles shall be poured in smooth water tight forms, so supported as to prevent appreciable deformation or settlement during pouring or curing. When removed from the form, the piles shall present true, smooth even surfaces free from honeycombs and voids and shall be such that a line stretched from butt to tip on any face will not be more than one (1) inch from the face of the pile at any point.

Concrete piles shall be kept continuously wet for at least ten (10) days after pouring and shall be allowed to harden for at least thirty (30) days before being lifted or driven, except that this thirty (30) day requirement may be decreased if the specimen of concrete from which the piles were poured develops a strength of three thousand (3000) pounds or more per square inch of compression.

When raising or transporting precast concrete piles, the contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete. Piles materially damaged in handling or driving shall be replaced. Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

50.9 Cast-In-Place Concrete Piles. Cast-in-place concrete piles shall consist of steel shells or casings driven permanently to the required bearing value and filled with concrete. Concrete filling for cast-in-place concrete piles shall be Class A or AA Portland cement concrete conforming to the requirements of Section 44 and 45 of these specifications. Reinforcement shall conform with the details shown on the plans and the requirements of Section 47 of these specifications.

Steel shells shall be of sufficient strength and rigidity to permit their driving, and to prevent distortion caused by soil pressures or the driving of adjacent piles until filled with concrete. The shells shall also be sufficiently water-tight to exclude water during the placing of concrete.

The shells may be cylindrical or tapered, step-tapered, or a combination of either with cylindrical sections. The tip diameter shall not be less than eight (8) inches and the butt diameter shall not be less than shown on the plans.

Shells to be driven without a mandrel shall be equipped with heavy steel driving ends and all joints in the shell shall be welded or adequately locked seamed.

After being driven and prior to placing concrete and reinforcing steel therein, the steel shells or casings shall be examined for collapse or reduced diameter at any point. Any shell or casing that is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value will not be accepted, and shall be replaced by the contractor at his own expense. Driven shells or casings shall be clean and free from water before concrete and reinforcing steel are placed. The contractor shall have available at all times a suitable light for the inspection of the shells, throughout the entire length, before they are filled with concrete and reinforcing steel.

50.10 Steel Piles. Steel piles shall be H-bearing of the section shown on the plans.

The length of steel pile ordered by the engineer may be built up in sections either before or during the driving operations. The sections, unless otherwise shown on the plans, shall be identical in cross-section. The connections shall be made by welding the entire cross-section in conformance with the requirements of Section 48, Article 48.22 "Welding" of these specifications. Care shall be taken to properly align the sections connected so that the axis of the pile will be straight. The number of welded connections in the length of a pile shall be preferably as few as practicable. If a welded splice is made during the driving operation, it shall be done when the top of the lower portion is at least three (3) feet above the ground, to permit observation of the welded connection during several feet of driving.

50.11 Test Piles. Test piles shall be the number, material and length shown on the plans or specified in the special provisions, and shall be so located that they may be cut off and become a part of the completed structures.

Test piles shall conform to the requirements for piling as specified in these specifications with the exception that when treated timber test piles are specified, the use of commercially treated piles will be permitted for use as test piles.

Test piles shall be driven with the same type of equipment as will be used for driving the bearing piles. Test piles or piles upon which a load test is made shall be the basis for determining the ordered length of the remainder of the piles.

50.12 Method of Measurement. The number of linear feet of timber, pre-cast concrete, steel piles or steel shells for cast-in-place piles to be paid for shall be the total ordered length of piles which are driven and which have been furnished in accordance with the lengths designated by the engineer, except that if the contractor casts concrete piles full length of the reinforcement bars to facilitate driving, no payment will be made for that portion where concrete must be removed in order that bars may project as shown on the plans.

Driving piles will be measured by the linear foot and the number of linear feet to be paid for shall be the total number of linear feet of piling remaining in the completed structure.

The length of test piles to be paid for shall be the actual lengths specified or shown on the plans.

Load tests will be measured on a lump sum basis.

50.13 Basis of Payment. (a) Furnishing Equipment for Driving Piles. Furnishing equipment for driving piles shall be paid for at the contract lump sum price bid for "Furnishing Pile Driving Equipment" which payment shall be full compensation for furnishing all necessary equipment, bringing it to the site, setting it up, and any necessary subsequent moving, removing it from the site, and for all labor, materials, tools, supplies, incidentals and doing all the work involved and necessary thereto.

(b) Furnishing Piles. Accepted quantities of this item will be paid for at the contract unit price bid per linear foot for "Furnishing Treated Timber Piles," " Furnishing Untreated Timber Piles,""Furnishing Steel Piles," "Furnishing Steel Shell for Piles", and "Furnishing Pre-Cast Concrete Piles" as the case may be, which payment shall include full compensation for furnishing the piling and all material required therefor ready for placing, including all material necessary for extensions and for completion of the pile and for all labor, tools, hauling, equipment, handling, treatment, and all work incidental to the construction of the piling prior to furnishing; and the furnishing and attachment of brackets, lugs, core stoppers and cap plates on steel piling.

(c) Driving Piles. The accepted quantities of this item will be paid for at the contract unit price bid per linear foot for "Driving Treated Timber Piles," "Driving Untreated Timber Piles," "Driving Pre-Cast Concrete Piles" "Driving Steel Piles" or "Driving Steel Shell for Piles", as the case may be, which payment shall include full compensation for furnishing all labor, tools, materials, supplies, and other necessary or incidental costs of handling, [illegible], driving, cutting off piles, treatment of pile heads, constructing build ups and extensions of concrete piles, painting of steel piles and all other incidental work connected therewith except that reinforcement, concrete and driving equipment shall be paid for under their respective items. It shall also include full compensation for all jetting, drilling, blasting or other work necessary to obtain the required penetration or bearing values of the piles.

(d) Splicing Steel Piles. The accepted quantities of this item will be paid for at the contract unit price each for "Metal Pile Splices" which price shall be full compensation for furnishing all labor, materials, tools, supplies and equipment necessary for the satisfactory completion of the work.

(e) Load Tests. The accepted quantities of this item shall be paid for at the contract lump sum price for "Load Tests" which price except as otherwise expressly provided shall be full compensation for all material, equipment, tools and labor incidental to making the test and to constructing the loading platform, procuring and placing the loading material and removing and disposing of platform material in a satisfactory manner.

(f) Cut-off lengths of piles shall be disposed of as set forth in Article 50.5.

SECTION 51 - PAINTING

51.1 Description. This item shall consist of the preparation of surfaces to be painted and the application, protection and drying of the required number of coats of paint of the kinds and at the points specified or ordered by the engineer.

51.2 Materials. All materials shall meet or exceed the minimum standards hereinafter set forth:

(a) Raw Materials. American Society for Testing Materials (ASTM) and Federal Specifications.

(b) Prepared Paints. Federal Specifications are specified to designate the type of material and standard of quality. Manufacturer's standard, first grade materials meeting or exceeding these requirements shall be used, as approved. Materials not bearing manufacturer's identification as a standard, first grade product, of his regular line, will not be considered.

(c) Proprietary materials when specified hereinafter by the manufacturer's trade name designate the standard of quality and type of material required. When the qualify or type of material required is not specified, the contractor shall apply for directions as to selection of materials and receive approval thereof from the engineer before proceeding; only the best quality of such materials shall be used, as determined by the engineer.

(d) Materials lists shall be submitted to the engineer for approval and none shall be used until such approval has been obtained. All materials proposed for use shall be delivered to the site in original containers, seals unbroken, stored where directed, and none may be used until approved by the engineer. Materials that are not approved must be immediately removed from the job site.

Samples will be taken by the engineer for testing when deemed necessary, cost of testing will not be charged against the contractor unless material tested fails to meet the requirements.

51.3 Number of Coats. Unless otherwise required in the special provisions, the number and kinds of coats of paint shall be as set forth in Table I herein.

51.4 Weather Conditions. Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather. Except as provided below, painting will not be permitted when weather conditions during application are such that the atmospheric temperature is at or below forty (40) degrees F. or when freshly painted surfaces may become damaged by rain, wind, dust or condensation, or when it can be anticipated that the atmospheric temperature will drop below forty (40) degrees F. during the drying period. If fresh paint is damaged by the elements it shall be replaced by the contractor at no additional cost to the department.

Subject to the approval of the engineer in writing the contractor may provide suitable enclosures to permit painting during inclement weather. Provisions must be made to control atmospheric conditions artificially inside the enclosures within the limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work and

no additional payment will be made therefor.

51.5 Application - General. All work shall be done by painters and finishers of established status and reputation for executing their work by the very best methods for each kind or type. Painting shall not be done except when the surface is dry and when weather conditions are satisfactory as set forth above.

Strict adherence to these specifications and the recommendations of the manufacturer whose materials are used shall be followed in the application. The contractor shall use such skills, equipment, materials and give his thorough attention to details as will provide thoroughly workmanlike and satisfactory results throughout.

Work which shows carelessness, lack of skill and execution, or which is defective due to any other cause shall be removed and refinished or repainted as directed without additional cost to the state.

On all surfaces which are inaccessible for brushing, the paint shall be applied by sheepskin dobbers especially constructed for the purpose, or by other means approved by the engineer.

If spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat or skips and holidays shall be considered as evidence that the work is unsatisfactory and the contractor may be required to apply the remainder of the paint by brush.

Mechanical mixers shall be used to mix the paint. The paint shall be mixed a sufficient length of time, prior to use, to thoroughly mix the pigment and vehicle together. Paint shall be kept thoroughly mixed while being applied, to keep the pigments in suspension.

Paint specified or formulated shall be ready for application and thinning will be allowed only on direction of the engineer.

The contractor shall protect all parts of the structure being painted against disfigurement by spatters, splashes and smerches of paint or paint materials. When paint is being applied on structure carrying public traffic, the contractor shall be responsible for any damage caused by his operations to passing vehicles or persons and may be required to use canvas shields or other protective means to guard against such damage.

Paint stains which might result in an unsightly appearance shall be removed by the contractor at his own expense.

51.6 Surface Preparation of Steel. The following methods of surface preparation apply to steel surfaces. The particular method or methods to be used will be specified in the special provisions.

(a) All dirt, mill scale, rust, stain, old paint and other foreign matter shall be removed from steel surfaces by an approved sandblast apparatus. Sandblasting shall be sufficient to give the surface the appearance of unpolished cast aluminum. Only sharp, dry sand of proper grading to give satisfactory results shall be used.

Unwashed beach sand containing salt or excessive amounts of silt will not be allowed.

When sandblasting is being performed on structures open to traffic, the contractor shall provide suitable protective devices to prevent damage to traffic.

When sandblasting is being performed near machinery, all journals, bearings, motors, and moving parts shall be sealed against entry of sand dust before sandblasting begins.

Unless otherwise authorized by the engineer, sandblasted surfaces shall be primed or treated the same day sandblasting is done. If cleaned surfaces rust before painting is accomplished, they shall be recleaned by the contractor at his own expense.

(b) Rust-Inhibitor Chemical Washes described in the special provisions shall be applied to freshly sandblasted steel surfaces prior to the application of the first undercoat of paint. Washes shall be applied in not more than four (4) hour intervals. If in the opinion of the engineer, atmospheric conditions are such that corrosion products form on freshly sandblasted surfaces in less than four (4) hours, treatment may be required at more frequent intervals.

Rust-inhibitor chemical washes may be applied by brush or spray, and they shall be applied in a careful manner to insure that all surfaces are covered.

During the application of the rust-inhibitor chemical wash no sandblasting will be permitted to the areas being treated.

No paint shall be applied until after the treated surfaces have thoroughly dried.

The first undercoat of paint shall be applied to the treated surfaces the same day that cleaning and washing have been done.

(c) Steam Cleaning. All dirt, grease, loose chalky paint or other foreign material which has accumulated on the previously painted surfaces shall be removed with an approved steam cleaning apparatus which shall precede all other phases of cleaning.

It is not intended that sound paint be removed by this process. Subsequent painting shall not be performed until the cleaned surfaces are thoroughly dry and in no case in less than twenty-four (24) hours after cleaning.

A detergent soap consisting of forty-five (45) per cent sodium metasilicate, forty-three (43) per cent sodium sesquasilicate, ten (10) percent sodium tetraphosphate and two (2) per cent Naconol shall be added to the feed water of the steam generator at the approximate rate of one (1) pound of detergent per two hundred(200) pounds of water.

Any residue which may accumulate on cleaned surfaces shall be removed by flushing with fresh water but washing down the cleaned surfaces will not otherwise be required.

(d) Hand Cleaning. All dirt, loose rust and mill scale, dead paint or paint which is not firmly bonded to the metal surfaces shall be removed by

wire brushes, either hand or powered, hand scraping tools or sandpaper.

Pneumatic chipping hammers will not be allowed unless authorized in writing by the engineer. Hand cleaning shall be sufficient to remove all loose material which would prevent the bond of succeeding coats of paint.

51.7 Painting Structural Steel. (a) Paint. Unless otherwise required on the plans or in the special provisions, the paints to be applied to steel surfaces shall consist of undercoats and a finish coat. The total dry film thickness of the undercoats shall not be less than three mils and the dry film thickness of the finish coat shall not be less than one mil. The dry film thickness of the paint will be measured in place with a calibrated magnetic film thickness gage.

Excessively thick coats of paint will not be permitted. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.

The paint used for the various coats shall be as specified in this specification or in the special provisions.

Succeeding coats of paint shall be of such shade as to contrast sharply with the coat being covered.

(b) Cleaning. Unless otherwise specified in the special provisions, after erection and riveting or welding, all surfaces of unpainted structural steel which will be exposed to air, shall be sandblasted in accordance with the requirements of Article 51.6 above.

In repainting existing steel structures where partial cleaning is required, the method of cleaning will be specified in the special provisions. Any damage to sound paint, on areas not designated for treatment, resulting from the contractor's operations shall be repaired to the satisfaction of the engineer.

(c) Painting. Painting of structural steel, except for sections which will be inaccessible after erection as described below, shall be done after erection unless otherwise specified in the special provisions. Requests to do any painting prior to erection shall be submitted by the contractor and approved by the engineer in writing before such work is started. The amount of painting done prior to erection will be limited to surface preparation and one undercoat of paint. Any deficiencies in the first coat of paint shall be corrected to the satisfaction of the engineer prior to the application of succeeding coats of paint.

Surfaces exposed to the atmosphere which would be inaccessible for painting after erection shall be painted the full number of coats prior to erection.

The surface of the paint coat being covered shall be free from moisture, dust, grease or any other deleterious material which would prevent the bond of the succeeding paint coats. In spot painting, any old paint which lifts after application of the first spot coat, shall be removed by scraping and the area repainted before application of the next coat.

The application of the finish coat will not be permitted until the required total film thickness of the undercoats of paint, as described in subarticle (a), above, is obtained.

Open seams at contact surfaces of built-up members which would retain moisture shall be caulked with red lead paste before applying the second undercoat of paint.

Metal surfaces embedded in concrete need not be painted.

(d) Machine Finished Surfaces. With the exception of abutting chord and column splices and column and truss shoe bases, machine finished surfaces shall be coated with a rust inhibitor which can be easily removed. Surfaces of iron and steel castings which have been machine finished shall be painted with a coat of shop paint.

(e) Frames and Grates. Prior to installation, all surfaces of frames and grates exposed to the atmosphere shall be painted with two coats of paint. Unless otherwise specified in the special provisions, the exposed surfaces shall be painted after installation with one finish coat as specified for structural steel.

51.8 Painting Timber. (a) Paint. Unless otherwise shown on the plans or specified in the special provisions, all new timber requiring painting shall be painted with three coats of paint. The paint used for various coats will be as specified in this specification or in the special provisions.

On all timber previously painted, the number of coats and types of paint will be as shown on the plans or specified in the special provisions and if not so shown or specified the number of coats and the paint to be used will be as directed by the engineer.

(b) Preparation of Surfaces. All cracked or peeled paint, loose chalky paint, dirt and other foreign matter shall be removed by wire brushing, scraping or other approved means immediately prior to painting. Unpainted timber shall be thoroughly dry before paint is applied.

(c) Painting. When permitted in writing by the engineer, the first coat of paint may be applied prior to erection.

After the first coat has dried and the timber is in place, all cracks, checks, nail holes, etc., shall be puttied flush with the surface and allowed to dry before the second coat is applied.

Skips, holidays, thin areas or other deficiencies in any one coat of paint shall be corrected to the satisfaction of the engineer before the succeeding coat is applied.

The surface of the paint coat being covered shall be free of any deleterious material before any additional paint is applied.

51.9 Painting Concrete and Concrete Masonry. (a) Surface Treating and Preparation. Immediately prior to the application of paint, or other coating treatment, surfaces shall be properly prepared to provide a surface that will insure a positive paint or painter treatment bond and eliminate possibility of any burn-through or other type of paint or coating failure.

Depending upon the condition of the surface and considering, but not limited to the paint manufacturer's recommendations, preparation shall consist of one or more operations or treatments as necessary; removal of all foreign or deleterious matter; acid or caustic wash to remove efflorescence, to neutralize alkali, or to create adequate porosity in the case of dense or glossy concrete; or other treatment as necessary to provide a surface cleaned and free of anything that might cause paint failure due to surface conditions.

(b) Painting. Painting of concrete or concrete masonry shall be done only if required by these specifications or in the special provisions. If required by these specifications or the special provisions the concrete masonry shall be hand brushed with not less than two coats of synthetic resin emulsion masonry paint as approved.

Material used shall be applied in full conformance with the manufacturer's directions and shall cover solid, shall be of uniform color and shall be free of laps, runs, brush marks, and other surface imperfections. If for any reason, a uniform finish is not obtained with two coats, additional coats shall be applied until such uniformity is obtained.

51.10 Measurement and Payment. No direct payment shall be made for painting, cleaning structural steel or preparing surfaces for painting. Compensation for this work shall be considered as included in the contract unit prices bid for the particular item requiring painting.

TABLE I

IRON & STEEL (Part A)

USE ITEM: Guard Rail, Elements, Standard Metal Rail, Guard Rail Hardware, Steel Bridge Railing

Purpose	Number of Coats	Color	General Type	Formula or Specification	Suggested Manufacturer's Brand
Prime (Applied at Shop)	1	--	Red Lead	TT-P-86a Type III	1. Devoe & Reynolds Co.,Inc.-Type III,GS-403 2. The Glidden Co. No.-Y-506 Liquid Red Lead 3. National Lead Co.-No. 052 Red Lead 4. W.P. Fuller & Co.-No.4550 Ful-Tec Red Lead 5. General Paint Corp.-No.2499 Red Lead 6. Themec Co. Inc.-No. 69 Spec. Red Primer 7. Pittsburgh Plate Glass Co.-No.LA-6250 Red Lead
			or Zinc Chromate	JAN-P-735	1. General Paint Corp.-#2452 Zinc Chromate 2. National Lead Co.-Dutch Boy #041 Zinc Chromate 3. Benjamin Moore & Co.-Moore's Iron Clad Zinc Chromate 4. Glidden Co.-#34-Y-708 Zinc Chromate
Intermediate (First Field Coat after Primer)	1	Cream	Titanium Lead, Zinc Oxide	TT-P-102a	1. Glidden Co.-#15-W-1 Posted 2. General Paint Corp. #1013 3. National Lead Co.-Dutch Boy #113 4. W.P. Fuller & Co.-Pure Prepared Paint 5. Benjamin Moore & Co.-1st Quality outside Paint.
Finish (Second Field Coat after Primer	1	White	Titanium Lead, Zinc Oxide	TT-P-102a	See above

TABLE I (con't.)
(Part B)

IRON & STEEL
USE ITEMS — Structural Steel, Miscellaneous Iron, Steel Light Standards, Steel Pile Shells, Steel Piles

Purpose	Number of Coats	Color	General Type	Formula or Specification	Suggested Manufacturer's Brands
(Prime (Applied at Shop)	1	---	Red Lead or Zinc Chromate	Fed. Spec. No. TT-P-86a Type III	See Part A.
Intermediate (first field coat after Primer)	1	Light Gray	Titanium Lead, Zinc Oxide	Fed. Spec.No. TT-P-102a	1. Glidden Co.-#15-W-1 Postad (Tinted) 2. General Paint Corp.-#1003 (Tinted) 3. National Lead Co.-Dutch Boy #113 (Tinted) 4. W.P. Fuller & Co.-Pure Prepared Paint (Tinted) 5. Benjamin Moore & Co.- 1st Quality Outside Paint (Tinted)
Finish (Second Field Coat after Primer)	1	---	Aluminum	Navy Spec. No. TT-V-81b Mixing Varnish Aluminum Paste TT-A468A, Type II.	1. The Glidden Co.-#Y-592 Exterior Metalite 2. General Paint Corp.-#3001 Bitulúmin 3. Benjamin Moore & Co.-Weaterproof Aluminum 4. National Lead Co.-Dutch Boy 29-oz. R. M. Aluminum

TABLE I (Cont.)

(Part C)

TIMBER USE ITEM: Timber Culvert Markers, Guide Posts, Cattle Guard Wings, Bridge Railings, Right-of-Way Markers, Sign Posts and Miscellaneous Timber Structures specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification	Suggested Manufacturer's Brands
Prime	1	White	Mixed Pigment Exterior Wood Primer	TT-P-25a	1. General Paint Corp. #1025 Prime-Tite 2. Sherwin-Williams SWP #450 Undercoater 3. National Lead Co. Dutch Boy #010 Primer 4. Devoe & Raynolds Co. #102 H.P. White undercoater 5. W.P. Fuller & Co. Pure Prepared Primer
Intermediate (First coat after primer)	1	Cream	Titanium Lead, Zinc Oxide	TT-P-102a	1. General Paint Corp. #1013 100% Pure Paint 2. National Lead Co. Dutch Boy #113 3. The Glidden Co. #15-W-1 (Tinted) 4. W. P. Fuller & Co., Pure Prepared Paint 5. Benjamin Moore & Co. 1st Quality Outside Paint
Finish (Second Coat after primer)	1	White	Titanium Lead, Zinc Oxide	TT-P-102a	1. General Paint Corp. #1003 100% Pure Paint 2. National Lead Co. Dutch Boy #113 3. W.P. Fuller & Co. Pure Prepared Paint 4. Benjamin Moore & Co. 1st Quality Outside Paint 5. The Glidden Co. #15-W-1 Postad
Trim, Lettering & Indications (Used when so indicated on plans)	1	Black	Titanium Lead, Zinc Oxide	TT-P-61b	1. National Lead Co. Dutch Boy #290 2. General Paint Corp. #1057 100% Pure Paint 3. W. P. Fuller & Co. Black Pure Prepared Paint 4. Benjamin Moore & Co. Black Decorative Trim 5. Devoe & Raynolds Co. - #103 H.P. Sash & Trim

TABLE I (Cont.)
(Part D)

CONCRETE USE ITEM — Concrete End Posts, (Bridges), Raised Traffic Bars, and miscellaneous concrete specified to receive paint.

Purpose	Number of Coats	Color	General Type	Formula or Specification	Suggested Manufacturer's Brands
Finish	1	White	Water thinned	Acrylic Resin or Synthetic Latex Alkyd Emulsion	1. General Paint Co. - "Faze" 2. Intercoastal Paint Co. - #303 or #202

SECTION 52 - PRESERVATIVE TREATMENTS FOR TIMBER

52.1 Description. Preservative treatment of approved lumber, timber, and piles shall consist of the types of treatment specified in pertiment sections of the standard specifications, as shown on the plans or required by the special provisions.

52.2 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set forth in these specifications.

52.3 General Requirements. Where painting of treated timber and lumber is indicated on the plans or set forth in these specifications, such lumber and timber that is to be painted with oil paint shall not be treated with creosote, creosote solutions, or oil-borne preservatives.

All timber and lumber treated with water-borne preservative shall be air-dried or kiln-dried after treatment and before use, to a moisture content that will not interfere with the application or retention of paint. It shall be the responsibility of the contractor to purchase the material in time to permit proper air-drying. In event of failure to place orders in time for air-drying, the cost and expense of kiln-drying shall be borne by the contractor.

Timbers of different size and retention requirements shall be treated in separate charges, except when the quantity of material ordered is insufficient, in which case timber of different size and retention requirements may be treated in the same charge, provided the total net retention for the charge shall not be less than the sum of the required retention for the quantities of each size-group in the same charge.

Round material and sawed material shall not be treated in the same charge.

Treated lumber, timber and piles shall be free from heat checks, water bursts, excessive checking, results of chafing, or from any other damage or defects which would impair their usefulness or durability for the purpose intended. The use of anti-splitting iron for repairing, or preventing checks, splits or other defects will not be permitted.

Empty-cell treatment shall be used with preservative oils and oil-borne preservatives except when the retention specified is greater than can be obtained by an empty-cell process. Water-borne preservatives may be injected by either a full-cell or an empty-cell process.

52.4 Treatment and Retention. Unless otherwise specified in the special provisions or modified herein, the treatment to be used and the amount of preservative to be retained shall meet the requirements of the current "Standard for Pressure Preserved Wood for Highway Construction, C-14", of the American Wood-Preservers Association. Maximum possible retention are recommended but in no case shall the retention be less than the minimum indicated herein or in the above mentioned A.W.P.A. Standard C-14. The following additional preservative is included as an alternate to those listed in A.W.P.A., C-14, and when specified herein, or when shown on the plans, shall be used and the requirements of the above standard shall apply, except as follows:

Chemonite . . . . . Min. net retention, pounds per cu. foot 0.45; full-cell process; Max. Temp. of treating bath 150° F.

52.5 Inspection. Timber, lumber and piles to be treated shall be inspected at the sawmill or concentration yard for grade suitability by an inspector designated by the engineer in accordance with the provisions of Section 107.

Timber, lumber and piles being treated shall be inspected by an inspector designated by the engineer, in accordance with the current "Standard Instructions for the Inspection of Presefvative Treatment of Wood, M-2," of the American Wood Preservers Association. The inspector shall file with the department the necessary inspection reports prescribed in Article 5.1 of the above mentioned Standard. Each treated pile and piece of treated lumber and timber accepted shall be branded by the inspector on the ends with a copyrighted brand differing from the brand used before treatment. A true impression of such brand shall be filed with the department. Treated lumber, timber and pile which do not bear in legible form the brands of the inspector for inspections made both before and after treatment shall not be used in the work.

52.6 Wood Preservative for Brush Treatments. The preservative to be used in brush application of lumber, timber and piling where specified shall be either Creosote for Brush or Spray Treatment or Anthracene Oil as specified in the Current "Standards for Preservative Oils for Non-Pressure Treatments, No. P-7," of the American Wood-Preservers Association.

At the time of applying the wood preservative the moisture content of the wood shall not exceed twenty (20) percent and there shall be no free moisture on the surface thereof. It shall not be applied in wet or damp weather except when the wood on which it is to be applied is adequately protected.

Wood preservative shall be applied with suitable brushes or by other means that will result in adequate penetration.

52.7 Payment. Full compensation for treatment of lumber, timber and piles as herein specified shall be considered as included in the price paid for furnishing treated lumber, timber or piling and no additional allowance will be made therefor.

SECTION 53
(BLANK)

SECTION 54 - CORRUGATED METAL PIPE CULVERTS

54.1 Description. This item shall consist of furnishing galvanized corrugated metal pipe culverts (full circle or deformed) and siphons, installed at locations designated on the plans or by the engineer, in accordance with these specifications, and to the lines and grades established. This item shall also include the furnishing and installation of flared-end sections, and the furnishing and construction of joints or connections to existing pipes, catch basins, end-walls, etc. as may be required to complete the work shown on the plans.

54.2 Materials. The materials used shall be those prescribed or used for the several items which constitute the finished work and shall conform with all the requirements for such materials as set out in Part III, Material Details. Specific reference to Part III is as follows:

Corrugated Metal Culvert Pipe . . . . . Section 101

Flared-end sections (metal headwalls) shall conform to the details and dimensions shown on the plans and except for shape, shall conform to the requirements of this section for corrugated metal pipe culverts.

Culverts shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of the spelter coating. Damaged spelter coating in lieu of the requirements of AASHO Designation: M36, may be repaired by thoroughly wire brushing the damaged area and removing all loose and cracked spelter coating after which the cleaned area shall be painted with two coats of zinc oxide - zinc dust paint conforming to the requirements of Federal Specification MIL-P-15145, the paint shall be properly compounded in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

When the spelter coating has been burned by welding, the interior and exterior surfaces of the welded connection shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked spelter removed, after which the cleaned area shall be painted as specified above. Culvert pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

54.3 Placing Corrugated Metal Pipe. When pipe is placed in a trench, the width of the trench shall not be greater than necessary to permit satisfactory jointing and thorough tamping of the backfill material under and around the pipe, unless otherwise authorized by the engineer. The culvert shall be laid to the lines and grades established by the engineer. The culvert shall be bedded on an earth foundation carefully graded to provide a firm and uniform bearing throughout the entire length of the culvert.

Where solid rock is encountered, it shall be removed to a depth of not less than twelve (12) inches below grade and the trench refilled with material of such character that will provide a compacted cushion under the culvert. When a firm foundation is not encountered due to the grade line of the structure crossing both soft and hard spots, all soft, spongy or other unsuitable material under the culvert for a width of not less than one diameter on each side of the culvert shall be removed, and the space refilled with gravel or other suitable material properly com-

pacted to provide adequate support for the culvert. When headwalls are not required and granular materials are used for bedding, the fill at the ends of the structure shall be sealed against the infiltration of water by bedding the ends of the structure in well tamped clay.

When shown on the plans or ordered by the engineer, where culverts are to be installed in new embankments, the embankment shall be constructed and compacted to the required height as shown on the plans, and for a distance each side of the culvert location of not less than five times the diameter of the culvert, after which the trench shall be excavated and the culvert installed in accordance with the provisions herein. When the culvert is to be installed on a steep slope or at a difficult location, the height of the embankment to be constructed in advance of installing the culvert may be varied as directed by the engineer.

Culverts under the highway shall be placed so that the minimum distance of the finished grade to the top of the pipe shall be not less than that shown in the following table:

Round or Elliptical Pipe

Surface Pavements	Base of Measurement	Up To 120" Dia.	Over 120" Dia.	Arches	Pipe Arches
Unpaved & Flexible	Top of Surface	D/5 or 12" Minimum	24" Minimum	S/15 or 12" min.	S/10 or 12" min.
Rigid	Top of Slab	D/7	18" Minimum	S/20	S/14

Note: Covers shown in table above are for finished construction. During construction, adequate cover shall be provided to protect the structure from damage.

Pipe culverts forty-eight (48) inches in diameter which are to be installed under fills twenty-five (25) feet in height or more and all pipes larger than forty-eight (48) inches in diameter shall be distorted from a full circular cross-section before any fill is placed.

The vertical diameter shall be forced out of around five (5) percent of the nominal diameter and retained in a shape by means of horizontal wire struts or vertical timber struts. The struts shall be left in the culvert until the fill has been completed. No headwalls shall be placed until the struts are removed and final settlement of the fill has occured.

54.4 Headwalls and Flared End Sections. Where shown on the plans, the ends of culverts shall be protected by concrete or masonry headwalls or by flared corrugated metal end sections with toe plates.

54.5 Siphons. Corrugated metal pipe for use as siphons shall be close riveted and soldered and so fabricated as to require a minimum number of field connections. All rivets and circumferencial seams shall be spaced at approximately two and one-half (2-1/2) inch centers with a maximum spacing of three (3) inches. The circumferencial and longitudinal seams on the outside of the pipe where the edges of the sheets lap, shall be soldered in a workmanlike manner, solder being sweated into the joints by means of a torch properly regulated

for the purpose. Soldering irons shall not be used on factory seams.

Except as provided hereinbefore siphons shall conform to the requirements for corrugated metal pipe culverts of this section.

Field joints for close riveted and soldered corrugated metal pipe shall be approved water tight couplings consisting of a corrugated collar drawn tight by means of threaded rods and silo-type lugs. To permit the band to fit snugly into the corrugation ends of the pipe and rivets in the longitudinal seam shall be emitted and the seams adequately soldered.

Before placing the band, the ends of the pipe and the bands shall be cleaned and an amount of plastic bituminous impregnated fibre sufficient to make a rope-like section approximately three-quarters (3/4) inch in diameter shall be carefully and evenly compressed into the last two valleys of the corrugation at the ends of the pipe. After placing the connecting band and entire circumference and assembly shall be hammered with a rubber or wooden mallet during the tightening of the bolts and lugs.

The contractor at his expense, prior to backfilling, shall completely fill the siphon with water and repair any leaks developing therein.

54.6 Protective Coating. When required by the special provisions, the pipe shall be furnished with bituminous or other type of protective coating, the requirements for such coating will be prescribed in the special provisions.

54.7 Extending Existing Culverts. Where shown on the plans or directed by the engineer, existing culverts shall be extended in accordance with the provisions for installing new culverts and the following additional provisions.

Existing head walls shall be demolished and removed and disposed of or moved to the extended location as indicated on the plans or ordered by the engineer.

A head wall that is not to be reset shall be demolished without injury to the existing culvert and removed and disposed of in accordance with the provisions of Section 13, of these specifications. Additional pipe shall be joined to the end of the existing pipe with a band coupler, and if shown on the plans or ordered by the engineer, a new concrete head wall shall be constructed in accordance with the provisions of Section 45 of these specifications, or a flared end section shall be attached thereto.

When the head wall is to be moved it shall be moved and reset in accordance with the requirements of Section 59 of these specifications.

54.8 Backfilling. After the culvert, or siphon or pipe extension has been placed in position, it shall be backfilled in accordance with the requirements of this section and the requirements of Section 22 of these specifications. Each layer of backfill material shall be compacted as therein specified to a relative density of not less than ninety (90) percent.

54.9 Method of Measurement. The length of pipe culverts (full circle or deformed) or siphons to be paid for shall be the actual number of linear feet of culvert or siphon in place, but this length shall not be greater than that shown on the plans or specified by the engineer. No allowance will be made for cut-offs on pipes placed on a skew when the pipe is ordered mitered at the factory. When skew cutoffs are ordered in the field, full allowance shall be made for the necessary length of pipe cut-off due to skew.

54.10 Basis of Payment. This item measured as provided above shall be paid for at the contract unit price bid per linear foot for "_____ inch Corrugated Metal Pipe," "_____ inch Corrugated Metal Arch Pipe," or "_____ inch Corrugated Metal Siphon Pipe," as the case may be, which payment shall include full compensation for furnishing all labor, materials, tools, supplies and equipment, and doing all the work involved in furnishing and installing the pipe complete in place as herein specified except structure excavation, backfill and headwall construction.

Corrugated metal pipe elbows, when required, will be paid for at the contract unit price bid per linear foot for the size of pipe involved measured along the center line.

The contract unit price bid each for "Metal Headwalls" shall include full compensation for furnishing all labor, materials, tools, supplies and equipment, and for doing all work involved in furnishing and installing the flared end sections complete in place as herein specified.

The construction of concrete or masonry headwalls will be paid for at the contract unit prices bid for the items of work involved.

Structure excavation and backfill required to be performed in connection with all work covered by this section, including mechanical tamping, the placing of gravel or granular material or other suitable material when necessary to provide adequate support for the pipe or when a firm foundation is not encountered as herein specified, will be measured and paid for as provided in Section 21, Section 22 and Section 23 respectively of these specifications.

Water, used as directed by the engineer to assist in compaction, will be measured and paid for as specified in Section 28 of these specifications.

Full compensation for field joints for siphons shall be considered as included in the contract unit price bid per linear foot for the siphon complete in place as herein specified.

SECTION 55 - REINFORCED CONCRETE PIPE CULVERTS

55.1 Description. This item shall consist of furnishing reinforced concrete pipe culverts, siphons and conduits of the kind, sizes and dimensions shown on the plans, or ordered by the engineer and in accordance with the provisions herein specified and installing such pipe at locations designated on the plans or by the engineer in conformity with the plans and to the lines and grades established. This item shall also include the furnishing and construction of such joints or connections to existing pipes, catch basins, end walls, etc., and for joining these sections of pipe together as may be required to complete the work shown on the plans.

Reinforced concrete pipe shall be of the class set forth in the estimate of quantities and the proposal.

55.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Reinforced Concrete Culvert Pipe. . . Section 104

55.3 Handling Pipe. Concrete pipe shall be carefully handled in unloading, transporting and laying.

No pipe shall be laid which is cracked, checked, spalled or damaged, and all such sections of pipe shall be permanently removed from the work. Pipes which show defects due to handling shall be rejected at the site of the installation regardless of prior acceptance.

55.4 Excavation and Backfill. All excavation shall be in accordance with the requirements of Section 21 and backfill shall be in accordance with the requirements of Section 22 except as herein set forth.

Provisions shall be made for bells if necessary.

Concrete pipe in trenches shall be laid true to line and grade as shown on the plans and as staked by the engineer. The bottom of the trench shall be graded and prepared to provide a true, uniform bearing throughout the entire length of the pipe. All pipe shall be laid upgrade unless otherwise permitted by the engineer. The sections shall be closely joined to form a smooth flow line. Pipe with eliptical reinforcements shall be placed with the minor axis of the reinforcement in a vertical position.

Insofar as possible, the sides of the trench shall be vertical at least to the top of the pipe.

Trenches shall be only of sufficient width to provide a free working space on each side of the pipe.

At the time of laying pipe, the prepared trench shall be in a reasonably dry condition. If ordered by the engineer, saturated material shall be removed from the trench and the space refilled with suitable material approved by him.

Necessary facilities shall be provided for lowering and properly placing the sections of pipe in the trench without damage.

All pipes which are installed in trenches the width of which is more than three times the maximum outside diameter of the pipe shall be treated as embankment pipe (pipe in projection).

When the pipe is laid in a trench in rock, hard clay, shale or other hard material, a space below the pipe shall be excavated and replaced with a bed of compacted sand or compacted earth fill. In no place shall the pipe be laid directly on the rock, hard clay, shale or other hard material.

When sand or compacted fill is used, the depth of the sand or compacted fill below the pipe shall not be less than one third the inside diameter of the pipe with a minimum of four (4) inches and a maximum of twelve (12) inches with the exception that an extra one-half (1/2) inch shall be added for every foot the trench exceeds sixteen (16) feet in depth. This bed shall extend at the sides of the pipe at least a distance of one-fourth the outside diameter of the pipe.

All trench and excavation shall be backfilled as soon as possible after the pipes are laid therein unless other protection of the pipe line is directed by the engineer, but no backfill shall be placed until the pipe has been checked for grade and line by the engineer. The backfill shall not be permitted to damage the joints before they are cured.

Backfill material shall be selected and deposited to insure the safety of the pipes. Backfill shall be suitable soil as clean as practicable, free from boulders, large roots or excessive amounts of sod or other vegetation.

The tamping of backfill around the pipe shall be done by mechanical tampers as prescribed in Section 22. Backfilling shall be carried up around the pipe in such a way as not to disturb joints, alignment or grade of the pipe.

Puddling or water flooding for consolidating the backfill shall not be used.

When laying pipe in embankments, (pipe in projection), all of the considerations of installing pipes in trenches shall apply. Pipe shall be laid to the proper line and grade and shall be bedded evenly and firmly.

Where pipes are to be installed in new embankment, (projection), the embankment shall first be constructed to the required elevation as set forth in the following methods "A" or "B". Method "A" shall be followed unless otherwise specified in the special provisions, and with the further exception that when the pipe is to be installed on a steep slope or at a difficult location, the height of embankment to be constructed in advance of installing the pipe may be varied as directed by the engineer.

METHOD A

In the case of pipes twenty-four (24) inches or less in diameter the roadway embankment shall be constructed to an elevation of six (6) inches above the grade proposed for the top of the pipe, after which the trench shall be excavated and the pipe installed.

In the case of pipes more than twenty-four (24) inches in diameter, the roadway embankment shall be constructed to an elevation of thirty (30) inches above the grade proposed for the bottom of the pipe, after which the trench shall be excavated and the pipe installed.

METHOD B

The new embankment shall be constructed and compacted to an elevation above the top of the pipe equal to the external diameter of the pipe and to a width each side of the pipe of not less than five times the diameter of the pipe, after which the trench shall be excavated and the pipe installed.

After the pipe has been installed, backfill material shall be placed. Material for use as backfill up to the top of the pipe shall be granular material approved by the engineer and shall be well compacted. Backfill between the top of the pipe and a point above the pipe equal to the external diameter of the pipe shall be placed in as loose as possible condition. At the time backfill material is placed above the pipe, the vertical surfaces of the trench above the top of the pipe shall not be more than one (1) foot outside the dimension of the pipe.

55.5 Laying Pipe - General. Mortar for joining pipe sections shall be composed of not less than one part Portland cement to two parts of clean, well graded sand. Mortar sand shall conform to the requirements of Section 90 of these specifications. The contractor shall determine his source of supply of sand for use in mortar a sufficient time in advance of pipe laying operations to permit sampling and testing before use, and no mortar shall be used until the sand has been approved by the engineer.

The consistency of joining mortar shall be such as to adhere to the ends of the pipe while being laid and may be easily squeezed out of the joint when the pipe sections are pressed together.

Pointing and banding mortar shall be plastic, and of such consistency that it will readily adhere to the pipe. All mortar shall be used within thirty (30) minutes after mixing with water.

Immediately before placing each section of pipe in final position for joining, the bedding for the pipe shall be checked for firmness and uniformity of surface.

In advance of joining sections of pipe, the ends of each section shall be washed clean with a wet brush, and immediately prior to placing mortar and joining the sections, the ends shall be thoroughly wetted.

Pipe sections shall be checked for alignment and grade at the time of joining the sections. If an adjustment in alignment or grade is necessary after making the joint, additional mortar shall be firmly pressed into the joint, and in the case of pipes less than twenty-four (24) inches in diameter, the internal and external surfaces of the joints shall be brushed.

In order to prevent joining mortar from prematurely setting, the ends of the pipe lines shall be covered in such a manner as to prohibit the flow of air during the time the mortar is in a plastic condition.

The interior of the pipe shall be kept free of dirt, excess mortar, and other foreign material as the pipe laying progresses, and left clean at the completion of the work. Any pipe which is not in true alignment or which shows any undue settlement after laying, or is damaged, shall be taken up and relayed at the contractor's expense.

Free water shall not be allowed to come in contact with the pipe line until the mortar in the joints has set at least twenty-four (24) hours.

Concrete pipe with eliptical reinforcing shall be suitably marked to clearly indicate the tops and bottom of the pipe.

55.6 Laying Culvert Pipe. The first section of pipe to be laid shall be firmly placed to the designated line and grade at the outlet end with the groove end or bell end pointing in the direction to be followed by the pipe laying.

Abutting ends of the sections of pipe to be jointed shall then be cleaned and wetted, after which joining mortar shall be firmly placed into the lower half of the groove end of the previously laid section. Joining mortar shall be firmly placed on the top half of the tongue end of the section to be jointed which shall then be inserted truly and snugly into the groove end of the section previously laid, so as to completely fill the joint.

The interior joint shall then be either brushed or pointed and all surplus mortar removed from the pipe. The external space between the ends of the jointed pipe shall be firmly filled from the outside with laying mortar.

When pipe with self-centering joints and without an inside pointing recess is furnished, the inside shoulder of the groove end of each section shall first be lightly plastered or buttered with joining mortar after which the pipe ends shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of the preceeding section in order to center the joint and form a true flow line. The inside joints shall be trowled or brushed smooth and excess mortar removed from the pipe. The outside joint recesses shall then be filled with mortar, after which backfilling shall be performed as specified.

When pipe is furnished with self-centering joints with both inside and outside pointing recesses, the pipe shall be firmly fitted together in such a way that the tongue end of each section fits snugly into the groove end of each preceeding section in order to center the joint and to form a true flow line, after which the inside joint recess shall be firmly filled with pointing mortar and then trowled or brushed smooth and excess mortar removed from the pipe, after which backfilling shall be performed as specified.

Backfill of the pipe trench may be completed while the joint mortar is still plastic. Should the joint mortar become set before the backfill is placed, backfilling of the trench shall not be commenced within sixteen (16) hours of jointing the pipe sections.

55.7 Rubber Gasketed Joints. Reinforced concrete pipe siphons shall be connected by flexible, watertight, rubber gasketed joints.

Reinforced concrete culvert pipe, connected by flexible, watertight, rubber gasketed joints may be used in lieu of other types of joints.

The rubber gaskets shall be endless rubber rings conforming to the following requirements:

All rubber gaskets shall be extruded or molded and cured in such a manner that any cross-section will be dense, homogeneous, and free from porosity, blisters, pittings and other imperfections. The gaskets shall be extruded or molded within a tolerance of plus or minus one-thirty-second (1/32) inch on any diameter measured at any cross-section. The rubber gasket shall be fabricated from a high-grade compound. The basic polymer shall be natural rubber or a copolymer of butadiene and styrene, or a blend of both. The compound shall contain no factice, and shall have the following characteristics:

Tensile strength, pounds per square inch, minimum	2,300
Elongation at break, percent, minimum	425
Shore durometer, Type A	40 to 65

The physical properties of the rubber compound will be determined by tests performed in accordance with current ASTM Designations: D412 and D676.

In advance of joining sections of pipe, the rubber gaskets shall be properly lubricated with a suitable vegetable compound soap or rubber lubricant.

After the pipe has been laid, the outer and inner annular space between pipe sections shall be completely filled with cement mortar, except that no mortar shall be required if the space is three-sixteenth (3/16) inch or less in width. Where reinforced concrete collars or bells with rubber gaskets are used at the pipe joints, mortar will not be required in the outer annular space. Where pipes are used with exposed metal surfaces at the joint, both the inner and outer annular joint spaces between pipe sections must be completely filled with cement mortar, except that pipes less than twenty-four (24) inches in diameter may be pointed inside by brushing smooth and removing all surplus mortar. The rubber gasket shall be the sole element depended upon to make the joint watertight for the purposes intended.

55.8 Method of Measurement. The lengths of reinforced pipe culverts, siphons and conduits to be paid for shall be the actual number of linear feet of culvert in place, but this length shall not be greater than shown on the plans or specified by the engineer. When cut-offs are ordered in the field or are cut off flush with the outside face of the headwall, full allowance shall be made for necessary lengths of pipe cut off.

When precast concrete flared end sections are installed, the full circle portions of such end sections will be included in the payment for the end sections and will not be measured for payment as a portion of the pipe.

Concrete pipe elbows will be paid for at the price per linear foot for the size of pipe involved, measured along the centerline.

55.9 Basis of Payment. This item, measured as provided above, shall be paid for at the contract unit price bid per linear foot for "_____ inch Reinforced Concrete Pipe Class _____," or "_____ inch Reinforced Concrete Siphon Pipe Class _____," as the case may be, which payment shall be full compensation for furnishing all labor, materials, tools, supplies and equipment, and doing all the work involved in furnishing and installing the pipe complete in place as herein specified, except excavation, backfill and headwall construction.

Excavation shall be measured and paid for as provided in Section 21.

Backfill, involved in installing the pipe, including the furnishing and placing of suitable material for pipe foundation, when necessary to provide adequate support for the pipe where a firm foundation is not encountered, or where rock, hard clay, etc., is encountered, as herein specified, shall be paid for as provided in Section 22 and Section 23 respectively of these specifications.

Concrete or masonry headwalls shall be paid for at the contract unit prices for items of work involved.

The contract unit price paid each for "Precast End Sections" shall include full compensation for furnishing all labor, materials, tools, supplies and equipment and doing all the work involved in furnishing and installing the end sections complete in place.

56.1 Description. This item shall consist of furnishing and installing non-reinforced concrete pipe or clay culvert pipe of the kind, sizes and dimensions shown on the plans or ordered by the engineer and accordance with the provisions herein prescribed.

Non-reinforced pipe may be either standard or heavy-wall. The standard non-reinforced concrete pipe shall be installed as irrigation pipe lines and for other drainage purposes and the heavy wall concrete pipe shall be used in lieu of reinforced concrete culvert pipe when so specified in the plans or in the special provisions.

Standard non-reinforced concrete pipe is not to be placed under the roadbed.

Clay culvert pipe shall be installed as shown on the plans or ordered by the engineer.

56.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Clay Culvert Pipe.	Section 103
Heavy Wall Concrete Culvert Pipe . .	Section 104
Non-Reinforced Concrete Pipe	Section 106

56.3 Construction Methods. The provisions of Articles 55.3, 55.4 and 55.5 shall apply where applicable.

External bands of mortar shall be placed around the pipe joints as herein specified. Several sections of pipe shall be joined before commencing banding operations, but the placing of external bands shall never be more than five (5) lengths of pipe behind joining operations.

Immediately in advance of placing external band mortar, the external surface of the pipe sections at the joint shall be thoroughly cleaned and wetted to insure proper bonding of the band mortar with the pipe. Care shall be exercised to make a union between the band and the mortar which was placed under the joint before the pipe sections were abutted. The band shall not be less than three-eighths (3/8) inch thick at the pipe joint and shall be approximately four (4) inches wide, overlapping the abutting ends of the pipe sections approximately two (2) inches. The edges of the band shall adhere to the pipe surface to prevent peeling and shall be finished in a workmanlike manner.

While the joint mortar is still plastic, selected backfill material (sandy material if available) of such size that all will pass a one-half (1/2) inch sieve and not more than five (5) percent will pass a No. 200 sieve, shall be carefully and loosely placed around and over the pipe line for the full width of the trench and to an elevation of approximately one (1) foot above the top of the pipe, after which the backfill shall be moistened, but not saturated with water. Moistening of the backfill shall be completed within twenty-four (24) hours after placing. The remainder of the trench backfill shall be placed while the joint mortar is plastic or such backfill shall not be placed within sixteen (16) hours of jointing the pipe.

Water shall not be turned into the pipe line until all backfilling is completed, and in no case within twenty-four (24) hours of finishing the pipe joints. Maximum hydrostatic pressure shall not be applied to the pipe line

within three (3) days of finishing the pipe joints.

Flexible, watertight rubber gasketed joints as specified in Article 55.7 may be used in lieu of other types of joints.

When irrigation or sewer pipe is placed outside the right-of-way limits the initial covering of backfill material shall be fine earth or sand approved by the engineer. Placing the remainder of the trench backfill in layers and compacting to a relative compaction of ninety (90) percent will not be required.

Openings shall be cut into irrigation or sewer pipe and connections made thereto as shown on the plans or directed by the engineer.

Openings shall be cut to proper sizes. Connections shall be cut to fit closely and shall be strongly cemented to the pipe with banding mortar. In all cases, the area of pipe where the connection is made shall be clean and wet when the mortar is applied.

56.4 Method of Measurement. The lengths of non-reinforced concrete pipe, heavy wall concrete culvert pipe and clay pipe to be paid for shall be the actual number of linear feet of culvert in place, but this length shall not be greater than shown on the plans or specified by the engineer. When cut-offs are ordered in the field or are cut off flush with the outside face of the headwall, full allowance shall be made for necessary lengths of pipe cut off.

When precast concrete flared end sections are installed, the full circle portions of such end sections will be included in the payment for the end sections and will not be measured for payment as a portion of the pipe.

Concrete pipe elbows will be paid for at the price per linear foot for the size of pipe involved, measured along the centerline.

56.5 Basis of Payment. This item, measured as provided above, shall be paid for at the contract unit price bid per linear foot for "_____ inch Non-Reinforced Concrete Pipe," "_____ inch Heavy Wall Concrete Culvert Pipe," "_____ inch Clay Pipe" or "_____ inch Clay Culvert Pipe" as the case may be, which payment shall be full compensation for furnishing all labor, materials, tools, supplies and equipment, and doing all the work involved in furnishing and installing the pipe complete in place as herein specified, except excavation, backfill, and headwall construction.

Excavation shall be measured and paid for as provided in Section 21.

Backfill, involved in installing the pipe, including the furnishing and placing of suitable material for pipe foundation, when necessary to provide adequate support for the pipe where a firm foundation is not encountered, or where rock, hard clay, etc., is encountered, as herein specified, shall be paid for as provided in Section 22 and Section 23, respectively, of these specifications.

Concrete or masonry headwalls shall be paid for at the contract unit prices for items of work involved.

The contract unit price paid each for "Precast End Sections" shall include full compensation for furnishing all labor, materials, tools, supplies and equipment and doing all the work involved in furnishing and installing the end sections complete in place.

Check for Clear

SECTION 57 - STRUCTURAL PLATE CULVERTS

57.1 Description. This item consists of furnishing and field assembling galvanized corrugated metal plates to form full circular or part circular culverts at locations shown on the plans or as directed by the engineer, all in accordance with these specifications and to the lines and grades given.

57.2 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set out in this specification and in Part III, Material Details. Specific reference to Part III is as follows:

Plates for Structural Plate Pipe and Arches. . . Section 101

57.3 Assembling. The culverts shall be assembled of plates of the gages indicated on the plans or in the proposal.

Damage to the spelter coating shall be repaired in accordance with the requirements of Section 54 of these specifications.

57.4 Construction Methods. Field assembled plate culverts shall be laid in a trench excavated true to the lines and grades established by the engineer. The trench shall be excavated with a square bottom and two (2) feet wider than the diameter of the culvert. The trench shall be graded to afford a firm and uniform bearing throughout the entire length of the culvert. Where the culvert is to be installed in new embankment, the embankment shall be constructed to the elevation as shown on the plans and for a distance each side of the culvert of not less than five times the diameter of the culvert, after which the trench shall be excavated and the culvert installed, except that when the culvert is to be installed on a steep slope or at a difficult location, the height of embankment to be constructed in advance of installing the culvert may be varied as directed by the engineer.

Plates forming the bottom of the culvert shall be laid first for the entire length of the culvert beginning at the downstream end. The side and top plates shall then be placed beginning at the upstream end and the work continued until all the plates are in position. Only a sufficient number of bolts shall be placed in each seam to hold the plates in position until the pipe periphery is completely assembled. The units shall not be tightened until all plates are in place and the full periphery completed.

In advance of placing any backfill material around full circle field assembled culverts, the full length of each culvert shall be distorted from a true circle by means of timber struts and sills placed in accordance with the details shown on the plans.

Unless otherwise specified, the field assembled pipes shall be timber struted vertically three (3) percent out around before placing of the fill.

The pipe shall be deformed the required amount by means of suitable jacks.

Strutting shall be carried uniformly from end to end of the pipe or pipes without headwalls. When headwalls are used there shall be no elongation of the ends of the pipe, but such elongation shall be between the shoulder points of the roadway. The struts shall be left in place until the fill is complete and compacted, unless otherwise ordered by the engineer. Removal of struts shall be at the expense of the contractor.

Where it is necessary to jack and strut structural plate culverts and if the contractor so elects, he may supply structural plate pipe with the vertical diameter increased five (5) percent by factory methods during the manufacture of the plates. Where eliptically formed plates are furnished, strutting will not be required when suitable granular material is used for backfill; if backfill is plastic, the eliptically formed culvert shall have timber struts wedged in place without causing further elongation.

The manufacturer recommendations and instructions shall be carefully followed in the installation of any structural plate culvert.

57.5 Backfilling. The outside of assembled culvert shall be given a thorough coating of an approved asphalt waterproofing material.

After the culvert has been assembled in position, the trench shall be backfilled in accordance with the requirements of this section and the requirements of Section 22 of these specifications.

The backfill material shall be deposited in layers uniformly on both sides of the pipe and shall be thoroughly tamped with mechanical tampers to not less than three-quarters of the height of the structure. The remainder of the backfill material shall be evenly distributed around and over the pipe (or arch) and thoroughly compacted. Dumping material on one side only will not be allowed. The fill material next to the pipe (or arch) shall be sand, fine gravel or pulverized earth free of stones, vegetation or other deleterious matter.

The backfill shall be compacted with mechanical tampers to not less than the three-quarter point of the pipe uniformly on both sides. Mechanical tampers shall conform to the requirements of Section 22 of these specifications.

Where indicated on the plans the ends of the culvert shall be protected by concrete or masonry headwalls constructed as shown on the plans. When headwalls are installed, the ends of pipe shall be neatly cut off flush with the outside face of the headwall.

57.6 Method of Measurement. The quantity of structural plate culverts to be paid for as follows:

Structural plate culverts with straight and vertical ends shall be measured in feet, end to end of metal, on the centerline of the structure.

Pipes with ends skewed or beveled, or both, shall be measured on the shortest and longest length and the average taken as the footage to be paid for.

57.7 Basis of Payment. This item, measured as provided above, shall be paid for at the contract unit price per linear foot for "_____inch Structural Plate Pipe (number of plates and gage)," "_____ inch Structural Plate-Arch," or "_____ inch Structural Plate Pipe-Arch," as the case may be, which payment shall be full compensation for furnishing, handling, erecting and installing the structure, and for all materials, labor, equipment, tools and incidentals necessary to complete this item.

Necessary excavation shall be measured and paid for as provided under Section 21.

Backfill, including mechanical tamping and the amount necessary to replace excavation below the grade of the pipe when required due to the character of material encountered, shall be measured and paid for as specified under Section 22 and Section 23, respectively.

SECTION 58 - RELAYING CULVERT PIPE

58.1 Description. This item shall consist of cleaning and relaying corrugated metal culvert pipe, previously removed, at the points called for on the plans or ordered by the engineer.

58.2 Construction Methods. The pipe shall be thoroughly cleaned to remove all foreign matter. Rust spots shall be thoroughly brushed with a wire brush and such cleaned spots shall be painted with an approved asphalt paint. The pipe shall then be laid in the manner prescribed for setting culvert pipe in Section 54.

58.3 Method of Measurement. The quantity to be paid for shall be the actual number of linear feet of culvert pipe, regardless of the size, relayed in the completed and accepted work.

58.4 Basis of Payment. The quantity of culvert pipe relayed, measured as provided above, shall be paid for at the contract unit price per linear foot for "Relay Culvert Pipe," which price shall be full compensation for cutting to lengths, cleaning and relaying the pipe, for necessary couplings to attach to existing pipes, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Necessary excavation shall be measured and paid for as provided under Section 21.

Backfill, necessary to replace excavation or backfill below, the grade of the pipe when required due to the character of the material encountered, shall be paid for as specified under Section 22 or Section 23, respectively.

Section 59 - Moving Pipe Culvert Headwalls

59.1 Description. This item shall consist of the removal of existing corrugated metal pipe culvert headwalls and the resetting of the headwalls at the location and to the elevations shown on the plans or ordered by the engineer.

59.2 Construction Methods. Fill shall be removed from around the headwall and for about two (2) feet along the pipe, and the pipe shall be cut smoothly along a plane perpendicular to its centerline at a point about one (1) foot back of the headwall. The headwall shall then be removed to its new location, as directed by the engineer, and placed upon a firm foundation escavated to the lines and grades as staked. Care shall be exercised in the moving operation, and any headwall broken or damaged by the contractor's negligence shall be replaced by him at his expense. The section of pipe projecting from the headwall shall be connected with the remainder of the specified length of culvert pipe by means of band couplings to form a continuous culvert having the required grade and alignment. When indicated on the plans or directed by the engineer, the connection shall be made with concrete collars in lieu of band couplings. Backfilling of the headwall in its new position and of the excavation from which it was removed, if required by the engineer, shall be performed as specified for backfill, Section 22.

59.3 Method of Measurement and Basis of Payment. The number of headwalls moved in the completed and accepted work shall be paid for at the contract unit price each for "Move Pipe Culvert Headwalls," which price shall be full compensation for cutting existing pipe, moving and resetting the headwalls, including the section of pipe attached to the headwall, and for all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work.

Excavation necessary for removing and resetting the headwalls shall be measured and paid for as set forth under Section 21.

Backfill shall be measured and paid for as specified in Section 22.

SECTION 60 - UNDERDRAINS

60.1 Description. This item shall consist of the installation of tile or perforated pipe underdrains, as specified, of the size and at the locations, true to line and grade, shown on the plans or ordered by the engineer.

60.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Backfill For Underdrains	Section 86
Portland Cement	Section 96
Corrugated Metal Pipe Underdrains	Section 102

Tile underdrains shall conform to the requirements of the current AASHO Designation: M66.

60.3 Trenching. A trench shall be excavated with a minimum width equal to the outside diameter of the pipe plus twelve (12) inches, and to the depth approximately six (6) inches below the grade shown on the plans or ordered by the engineer.

The space below the grade shall be filled with the required drain backfill throughout its entire length, thoroughly compacted, and brought to a uniform grade. All material excavated from trenches, not required for backfilling, nor usable in the roadway, shall be removed and disposed of by the contractor.

60.4 Laying Pipe. Bell and spigot tile shall be laid upgrade with the bell end upgrade and the spigot end not quite fully entered in the adjacent bell. Pipe shall be laid, true to line and grade, with a uniform bearing under the full length of the barrel. The pipe joints shall then be covered with two-ply tar paper strips not less than six (6) inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of drain backfill on either side of the pipe for a distance of three (3) inches.

Perforated pipe shall be laid with the perforations at the bottom of the pipe and the sections joined with band couplers. The pipe shall be firmly bedded throughout its length.

60.5 Backfilling. After the pipe has been laid and approved by the engineer, drain backfill shall be placed carefully around and over the pipe to within twelve (12) inches of the ground surface or if the underdrain is within the roadbed subgrade area, the drain backfill shall be brought to subgrade elevation, or as directed by the engineer. This material shall be placed in layers not exceeding six (6) inches in thickness, and each layer shall be thoroughly tamped and compacted with an approved tamping tool. The upper twelve (12) inches of the trench shall then be filled with suitable material of either porous or impervious type, as directed by the engineer, and thoroughly compacted.

If an item for grouting drain backfill is shown in the proposal, drain backfill which has been thoroughly compacted shall be covered with a thick grout not less than one (1) inch in thickness. The grout shall be composed of one part Portland cement and five parts sand and shall be prepared in accordance with

Article 65.4. This grout shall be thoroughly tamped to provide an impervious layer over the entire surface of the drain backfill.

60.6 Method of Measurement. The length of underdrain to be paid for shall be the actual number of linear feet, measured along its axis, complete in place and accepted.

The quantity of grouted drain backfill to be paid for shall be the actual number of linear feet of drain grouted, measured along the longitudinal axis of the drain, in the completed and accepted work.

The quantity of excavation to be paid for shall be the number of cubic yards removed to the depth specified, except that the width to be paid for shall be limited by vertical surfaces whose distance apart shall be the exterior diameter of the pipe plus twelve (12) inches.

The quantity of drain backfill to be paid for shall be the number of cubic yards of backfill complete in place and accepted, except that no quantities shall be paid for outside of vertical planes whose distance apart is equal to the exterior diameter of the drain plus twelve (12) inches. Backfill placed to a depth greater than six (6) inches below the drain shall not be paid for unless ordered by the engineer.

60.7 Basis of Payment. The quantity of underdrain laid, measured as provided above, shall be paid for at the contract unit price per linear foot for "____ inch Tile Underdrain," or "____ inch Perforated Underdrain," as the case may be, which price shall be full compensation for furnishing and installing the pipe, including special sections where needed, for all connections to existing pipes or structures, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

The quantity of excavation, measured as provided above, shall be paid for as specified under Section 21.

The quantity of bedding and backfill, measured as provided above, shall be paid for at the contract unit price per cubic yard for "Drain Backfill," which price shall be full compensation for stripping pit, crushing, screening, loading, hauling, placing, and tamping backfill and for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

The quantity of grouted drain backfill, measured as provided above, shall be paid for at the contract unit price per linear foot for "Grouting Drain Backfill," which price shall be full compensation for furnishing all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 61 - METAL EMBANKMENT PROTECTORS

61.1 Description. This item shall consist of furnishing and installing corrugated metal downdrain pipe and asphaltic coated corrugated metal embankment protectors conforming to these specifications and of the size and dimension shown on the plans, and in conformity with the lines and grades shown on the plans or ordered by the engineer.

61.2 Materials. Embankment protectors and downdrain pipe shall be fabricated of galvanized corrugated metal of not less than No. 16 gage, conforming to any one of the types specified in the current "Standard Specifications for Corrugated Metal Pipe Underdrains", AASHO Designation: M136, except that the pipe shall not be perforated as required therein.

Embankment protectors shall be coated at the plant before shipment with an approved asphaltic dip. The downdrain pipe shall be asphalt coated when indicated in the proposal.

61.3 Construction Methods. The embankment protector outlet pipe shall be connected to a downdrain pipe of the dimensions shown on the plans by means of a band coupler or a slip joint.

Embankment protectors shall be installed at the outside edge of the embankment gutters or in shoulder dikes to carry drainage from the roadbed down the embankment slopes to protect the slopes and shoulders from erosion. The entrance device shall be so installed as to prevent water from percolating around the structure and care shall be taken to prevent the structure from being undermined. The seal between the structure and the surrounding earth shall be made watertight. The embankment protectors shall be placed in such a manner that the lower edge of the opening will be from three (3) inches to six (6) inches below the bottom of the gutter flow line.

A galvanized metal downdrain pipe shall be securely fastened to the receiving chamber and shall be installed and handled in the manner specified in Section 54, with the exception that where it is not possible to provide a trench for the installation, the pipe shall be securely anchored to the surface of the ground, as provided in the plans or directed.

61.4 Method of Measurement. The embankment protector assembly, including two (2) feet of outlet pipe as shown on the standard plan, will be measured by the unit complete in place.

The length of corrugated metal downdrain pipe to be paid for shall be the actual number of linear feet of downdrain pipe in place, exclusive of the two (2) feet of outlet pipe attached to the embankment protector as provided above for measurement of embankment protectors.

61.5 Basis of Payment. The accepted quantities of this item measured as provided above shall be paid for at the contract unit price bid each for "Embankment Protectors", which payment shall be full compensation for furnishing all labor, materials, tools, supplies and equipment and doing all the work involved

in furnishing and installing the embankment protector complete in place as herein specified and as shown on the plans.

Full compensation for all excavation and backfill involved in installing the embankment protectors shall be considered as included in the contract unit price paid for the embankment protector downdrain pipe and no separate payment will be made therefor.

Corrugated metal pipe downdrains measured as provided above shall be paid for at the contract unit price bid per linear foot for " ____ inch Corrugated Metal Pipe Downdrain", which payment shall be full compensation for furnishing the pipe, band couplers, or slip joints, and for doing all the work involved in installing the downdrain pipe complete in place as herein specified, including the necessary excavation and backfill.

SECTION 62 - CATCH BASINS, INLETS AND MANHOLES

62.1 Description. This item shall consist of the construction of catch basins, inlets, or manholes of Portland cement concrete, together with the necessary drains, grates, or covers at points and of the designs shown on the plans and in conformity with these specifications.

62.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Coarse Aggregate for Portland Cement Concrete	Section 85
Fine Aggregate for Portland Cement Concrete	Section 88
Portland Cement	Section 96
Structural, Rivet, and Eyebar Steel	Section 97
Gray Iron Castings	Section 98

62.3 Construction Details. Catch basins, inlets, and manholes shall be constructed in accordance with all of the requirements of Section 45. Inlet and outlet pipes shall be placed prior to pouring concrete.

Grates shall be set in full mortar beds or otherwise secured as shown on the plans. Mortar for setting grates shall be mixed in the proportions of one part cement to three parts of fine aggregate. Grates shall be set accurately to the final elevation so that no subsequent adjustments will be necessary. Concrete covers, when indicated on the plans, shall be constructed in such manner that they will fit snugly and be readily removable. Structural steel grates shall be painted as specified in Section 51.

62.4 Method of Measurement. Grates of either cast iron or structural steel, as indicated on the plans, shall be measured in pounds. The weight of castings shall be computed from the dimensions shown on the approved shop drawings, assuming the cast iron to weight four hundred and fifty (450) pounds per cubic foot, with an allowance of ten (10) percent for fillets and overrun. The weight of structural steel grates shall be computed from the dimensions shown on the approved shop drawings, in accordance with Section 48.

62.5 Basis of Payment. Concrete shall be measured and paid for as specified in Section 45.

Reinforcing steel shall be measured and paid for as specified in Section 47.

Grates, measured as provided above, shall be paid for at the contract unit price per pound for "Castings" or "Structural Steel Grates", as the case may be, which price shall be full compensation for furnishing,

fabricating, and installing grates, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

Necessary excavation shall be measured and paid for in accordance with Section 21.

Backfill shall be measured and paid for in accordance with Section 22.

Inlet and outlet pipes shall be measured and paid for in accordance with the specifications for the particular type of pipe required.

SECTION 63
(BLANK)

SECTION 64 - RIPRAP

64.1 Description. This item shall consist of furnishing and placing riprap (with or without grout) heavy riprap or sacked portland cement concrete riprap, as the case may be, in accordance with the requirements of the plans and these specifications.

64.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Stone for Masonry and Riprap	Section 87
Portland Cement	Section 96

When so provided, waste concrete slabs may be substituted for the above-designated stone. In such case, the concrete shall be sound and the slabs shall meet the size requirements as specified for stone.

Unless otherwise provided in the special provisions, aggregate for use in sacked concrete riprap shall consist of river run material of a sandy, gravelly nature, clean and free from roots, vegetable matter and other deleterious substances. When tested on laboratory sieves, river run material shall conform to the following grading requirements:

Passing a 2-inch sieve	80% to 100%
Passing a No. 200 sieve	0% to 4%

64.3 Construction Methods. (a) Excavation. The bed for the riprap shall be properly trimmed and shaped.

(b) Placing Riprap. Stone placed below the water line shall be distributed so that the minimum thickness of the riprap is not less than that specified.

Stone placed above the water line shall be placed by hand. It shall be laid with close, broken joints and shall be firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with the ends in contact. The riprap shall be thoroughly compacted as construction progresses and the finished surface shall present an even, tight surface. The larger stone shall be placed in the lower courses. Interstices between stones shall be chinked with spalls firmly rammed into place.

Unless otherwise provided, riprap shall be at least twelve (12) inches in thickness, measured perpendicular to the slope. The surface of riprap placed above the water line shall not vary from the theoretical surface by more than three (3) inches at any point.

(c) Placing Heavy Riprap. Heavy riprap may be placed by any mechanical means that will produce a completed job within reasonable tolerances of the typical section shown on the plans. Heavy riprap shall be not less than twenty (20) inches thick. Hand work will be limited to the amount necessary to fill large voids or to correct segregated areas.

(d) Grouted Riprap. When grouted riprap is specified, the stone shall be laid as set forth above for riprap placed above the water line. The spaces between the stones shall then be filled with cement mortar. Sufficient mortar shall be used to completely fill all voids, except that the face surface of the stone shall be left exposed.

Grout shall be composed of one part by volume of Portland Cement and

three parts by volume of sand and shall be of such consistency that it will fill voids in the riprap. Mixing shall be as specified in Section 65. After grouting is completed, the surface shall be cured as specified in Section 45 for a period of at least three (3) days.

(e) Sacked Portland Cement Concrete Riprap. The mixed concrete shall contain three hundred seventy-six (376) pounds (4 sacks) of Portland Cement per cubic yard.

The amount of water added at the time of mixing shall be such as will produce a mixture with a slump of from three (3) inches to five (5) inches when tested in accordance with the method described in Section [illegible] of these specifications.

Sacks for concrete riprap shall be made of at least ten (10) ounce burlap and shall be approximately nineteen and one-half (19-1/2) inches by thirty-six (36) inches measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately one and twenty-five hundredths (1.25) cubic feet. Sound reclaimed sacks may be used. The sacks shall be filled with concrete, loosely placed so as to leave room for folding at the top, the fold to be just enough to retain the concrete at the time of placing. Not more than one (1) cubic foot of concrete shall be placed in each sack. Immediately after being filled with concrete, the sacks shall be placed and lightly trampled to cause them to conform with the earth face and with adjacent sacks in place.

The slopes on which the sacked concrete riprap is to be placed shall be finished true to line and grade. The first course shall consist of a double row of stretchers laid in a neatly trimmed trench, and the second course shall consist of a single row of headers. The third and remaining courses shall consist of stretchers and shall be placed in such a manner that joints in succeeding courses are staggered. All dirt and debris shall be removed from the top of the sacks before the next course is laid thereon. Stretchers shall be placed so that the folded ends will not be adjacent. Headers shall be placed with the folds toward the earth face. Not more than four vertical courses of sacks shall be placed in any tier until initial set has taken place in the first course of any such tier.

When in the opinion of the engineer, there will not be proper bearing or bond for the concrete due to delays in placing succeeding layers of sacks or due to the work having been hampered by storms, or mud, or for any cause, a small trench shall be excavated back of the row of sacks already in place, which trench shall be filled with fresh concrete before the next layer of sacks is laid. Excavating these trenches will be paid for as structure excavation and concrete placed in the trenches will be paid for at the price per cubic yard for sacked concrete riprap.

Sacked concrete riprap shall be cured by covering with a blanket of wet earth or by sprinkling with a fine spray of water every two (2) hours during the daytime for a period of four (4) days.

64.4 Method of Measurement. Stone riprap shall be measured by the cubic yard in place in the completed work, and the quantity thereof to be paid for shall be the summation of cubic yards of such riprap incorporated in the work in accordance with the contract. Sacked concrete riprap will be measured at the mixer by the cubic yard. Only accepted work will be measured for payment, and the computation of the quantity thereof will be based on the volume within the limiting dimensions designated on the plans or as fixed by the engineer.

64.5 Basis of Payment. (a) Riprap and Heavy Riprap. These items, measured as provided above, will be paid for at the contract unit price bid per cubic yard for "Riprap" or "Heavy Riprap" as the case may be.

(b) Grouted Riprap. This item, measured as provided above, will be paid for at the contract unit price bid per cubic yard for "Grouted Riprap."

(c) Sacked Concrete Riprap. This item measured as provided above will be paid for at the contract unit price bid per cubic yard for "Sacked Concrete Riprap."

Payments specified above shall be full compensation for furnishing all labor, materials, tools, supplies and equipment and doing all work involved in placing riprap as herein specified and ordered by the engineer, except that excavation for trenches, footings, etc., within the limits shown on the plans or ordered by the engineer, will be measured and paid for in accordance with Section 21 of these specifications.

Backfill shall be considered as included in the price paid for excavation and no separate payment will be made therefor.

SECTION 65 - RUBBLE MASONRY

65.1 Description. This item shall consist of furnishing rubble masonry consisting of roughly squared and dressed stone laid with or without mortar and constructed in such shapes and at such places as are indicated on the plans or ordered by the engineer.

Mortar rubble masonry shall include the classes commonly known as course, random, and random range work laid in cement mortar.

Dry rubble masonry shall include the classes commonly known as course, random, and random range work laid without mortar.

65.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Stone for Masonry	Section 87
Mortar Sand	Section 90
Portland Cement	Section 96

65.3 Construction Methods. (a) Size of Stone. Individual stone shall have a thickness of not less than six (6) inches and a width of not less than one and one-half times the thickness. No stones, except headers, shall have a length less than one and one-half times their width. Stones shall be decreased in thickness from bottom to top of wall.

Headers shall hold in the heart of the wall the same size shown in the face and shall extend not less than twelve (12) inches into the core or backing. They shall occupy not less than one-fifth the face area of the wall and shall be evenly distributed. Headers in walls two (2) feet or less in thickness shall extend entirely through the wall.

(b) Shaping and Dressing Stone. The stones shall be roughly squared on joints, beds, and faces. Selected stone, roughly squared and pitched to line, shall be used at all angles and ends of walls. If specified, all corners or angles in exterior surfaces shall be finished with a chisel draft.

All shaping or dressing of stone shall be done before the stone is laid in the wall, and no dressing or hammering which will loosen the stone will be permitted after it is placed.

65.4 Mortar. Mortar shall be composed of one part by volume of Portland cement to two parts by volume of clean sand. Hydrated lime, to the extent of eight (8) percent by volume of the cement, may be added to the mortar. Mortar for pointing shall be composed of one part cement to two parts clean sand; hydrated lime, to the extent of ten (10) percent by volume of the cement may be added to the mortar. Hydrated lime shall be treated as an addition to and not as replacing any cement.

Unless otherwise permitted by the engineer, the mortar shall be machine mixed. Machine mixed mortar shall be prepared in an approved mixer and shall be mixed not less than one and one-half (1-1/2) minutes. Should hand mixing of the mortar be permitted by the engineer, the sand and cement shall be thoroughly mixed together in a clean, tight mortar box until the mixture is of uniform color, after which clean water shall be added in such a quantity as to form a stiff paste, so that it can be easily handled and spread with a trowel. Mortar shall be used within forty-five (45) minutes after mixing. Retempering of mortar will not be permitted.

65.5 Placing. (a) Mortar Rubble Masonry. Mortar rubble masonry shall not be constructed in freezing weather or when the stones contain frost, except by written permission of the engineer and subject to such conditions as he may require.

Each stone shall be thoroughly cleaned and thoroughly saturated with water before being set and the bed which is to receive it shall be clean and well moistened. All stones shall be well bedded in freshly made mortar.

When possible the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them to a depth of two (2) inches before the mortar has set. The face surfaces of stone shall not be smeared with the mortar forced out of the joints or that used in pointing.

In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from the bed and joints, and the stone reset in fresh mortar.

The masonry shall be laid to lines and in courses roughly leveled out. The bottom of foundation courses shall be composed of large, selected stones and all courses shall be laid with bearing beds parallel to the natural bed of the material.

The mortar joints shall be full and the stones carefully settled in place before the mortar has set. No spalls will be permitted in the beds. Joints and beds shall have an average thickness of not more than one (1) inch. The vertical joints in each course shall break with joints in adjoining courses at least six (6) inches. In no case shall the vertical joint be so located as to occur directly above or below a header. Flat and stratified stone shall be laid in an approximate horizontal position and not on an edge. Wall construction shall not be commenced until the wall foundation has been approved by the engineer.

(b) Dry Rubble Masonry. The masonry shall be laid to line and in courses roughly leveled out. The bottom or foundation courses shall be composed of large, selected stones and all courses shall be laid with bearing beds parallel to the natural bed of the material. Face joints shall not exceed one (1) inch in width.

In laying dry rubble masonry, care shall be taken that each stone takes a firm bearing at not less than three (3) separate points upon the underlying course. Open joints, both front and rear shall be "chinked" with spalls fitted to take firm bearing upon their top and bottom surfaces, for the purpose of securing firm

bearing throughout the length of the stone. When required by the special provisions, the open joints on the rear surfaces of abutments or retaining walls shall be "slushed" thoroughly with mortar to prevent seepage of water through the joints.

65.6 Copings, Bridge Seats and Backwalls. Copings, bridge seats and backwalls shall be of the dimensions and materials shown on the plans and when not otherwise specified shall be of Class A or AA concrete which shall conform to the requirements of Section 45.

65.7 Pointing. Pointing shall not be done in freezing weather or when the stone contains frost.

Joints not pointed at the time the stone is laid shall be thoroughly wet with clean water and filled with mortar. Mortar shall be well driven into the joints and finished with an approved pointing tool. The walls shall be kept wet while pointing is being done and in hot or dry weather the pointed masonry shall be protected from the sun and kept wet for a period of at least three days after completion. After the pointing is completed and the mortar set, the work shall be thoroughly cleaned and left in a neat and workmanlike condition.

65.8 Method of Measurement. Quantity of rubble masonry to be paid for shall be the number of cubic yards measured in the completed work and the limiting dimensions shall not exceed those shown on the plans or fixed by the engineer. No deductions will be made for weep holes, drainpipes, or other openings of less than two (2) square feet in area. Coping, bridge seats, and backwalls, except when constructed of concrete, shall be considered as rubble masonry and shall be measured for payment as such.

65.9 Basis of Payment. The quantities measured as provided above shall be paid for at the contract unit price bid per cubic yard for "Mortar Rubble Masonry" or "Dry Rubble Masonry", as the case may be, which payment shall include full compensation for furnishing all labor, materials, tools, supplies, and equipment and doing all the work involved in constructing the rubble masonry complete in place as herein specified.

When concrete copings, bridge seats, or backwalls are specified, this part of the work shall be measured and paid for as provided under Section 45.

Necessary excavation shall be measured and paid for as provided under Section 21.

SECTION 66 - BITUMINOUS TREATED FOOTPATHS

66.1 Description. This item shall consist of a bituminous footpath constructed in accordance with these specifications at points and of the design and dimensions shown on the plans or ordered by the engineer.

66.2 Materials. All materials shall conform to the requirements for the several items which constitute the footpath.

66.3 Construction Methods. The area for the footpath shall be graded to the lines and grades indicated on the plans or ordered by the engineer in accordance with the applicable portions of Sections 12 to 20, inclusive. Prior to placing the footpath, a satisfactory subgrade shall be prepared true to lines and grades established by the engineer. It shall be thoroughly watered and compacted by rolling and tamping until hard and smooth. All soft and unsuitable material shall be removed and replaced with suitable material.

Side forms consisting of two (2) inch by four (4) inch "Construction" grade Douglas fir shall be carefully placed to a full and firm bearing before the footpath is constructed. Forms shall be secured by nailing to two (2) inch by four (4) inch by two (2) foot stakes.

Base and surface courses shall be constructed in accordance with the specifications for the particular items required.

Subgrade and base and surface courses shall be rolled until thoroughly compacted with a roller providing a compression of not less than two hundred (200) pounds per linear inch of roller width. Portions of the subgrade disturbed in the process of setting side forms shall be recompacted.

The completed footpath shall be true to lines, grades, and cross sections, and the surface shall be smooth, hard, and compact.

66.4 Method of Measurement. When the proposal contains such an item, the quantity to be paid for shall be the number of square yards of footpath complete in place in the accepted work, measured between the side forms.

When the proposal does not contain such an item, the quantities of the various items which constitute the completed and accepted footpath shall be measured for payment according to the plans and specifications for the several pay items and in terms of the units provided for such items.

66.5 Basis of Payment. When the proposal contains such an item, the quantity, measured as provided above, shall be paid for at the contract unit price per square yard for "Bituminous Footpath," which price shall be full compensation for preparing the subgrade, furnishing and installing side forms, placing base and surface courses, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, except that excavation, borrow, select borrow, and overhaul shall be paid for as prescribed for those items.

When the proposal does not contain such an item, the quantities, measured as provided above, shall be paid for at the contract unit prices for the several pay items constituting the footpath and listed in the proposal, which prices shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

SECTION 67 - CONCRETE CURBS, GUTTERS AND SIDEWALKS

67.1 Description. Curbs, gutters, sidewalks, local depressions and driveways of the form and dimensions shown on the plans shall be constructed of Class A or AA concrete as shown in the proposal, mixed and placed as provided in Sections 44 and 45 of these specifications, with the following modifications and additional requirements.

67.2 Subgrade Preparation. The subgrade shall be constructed true to grade and cross-section, as shown on the plans or directed by the engineer. It shall be thoroughly watered and rolled or hand tamped until hard and solid before placing the concrete. All soft and spongy material shall be removed to a depth of not less than six (6) inches below subgrade elevation for curbs, gutters, local depressions and driveways and three (3) inches below for sidewalks, and the resulting space filled with earth, sand or gravel of a quality that when moistened and rolled or tamped will form a firm and solid foundation.

The completed subgrade shall be tested for grade and cross-section by means of a templet extending the full depth and supported on the side forms. The subgrade and forms shall be thoroughly watered in advance of placing concrete.

67.3 Existing Curbs, Gutters and Sidewalks. Where the plans provide for reconstruction of existing curb and sidewalk and the limit of new work specified does not fall on a scoring line, the entire section shall be removed and the new curb and sidewalk shall join the old curb and sidewalk at the first scoring line beyond said specified limit.

67.4 Forms. The depth of forms for curbs shall be equal to the full depth of the curb. The depth of outside forms for concrete gutters shall be equal to the full thickness of the gutter. Timber forms if used, shall be surfaced on the side placed next to the concrete, and shall have a true smooth upper edge, and shall not be less than one and five-eights (1-5/8) inches thick after being surfaced. Warped forms and forms not having a smooth, straight upper edge shall not be used.

Benders or thin plank forms, rigidly placed, may be used on curves, grade changes, or for curb returns.

Back forms for curb returns may be made of one-half (1/2) inch benders, for the full height of the curb, cleated together. Forms shall be carefully set to alignment and grade and to conform to the dimensions required. Forms shall be held rigidly in place by the use of pairs of iron stakes placed at intervals not to exceed four (4) feet. Clamps, spreaders, and braces shall be used where required to insure rigidity in the forms.

The form on the front of curbs shall not be removed in less than two (2) hours nor more than six (6) hours after the concrete has been placed. Forms on the back of curbs shall remain in place for at least one (1) hour after the grout has been applied to the curb. In no event shall the form be removed while the concrete is sufficiently plastic to slump upon removal of the form. Side forms for sidewalks shall not be removed in less than twelve (12) hours after the finishing has been completed.

All forms shall be cleaned throughly each time they are used and coated with a light oil as often as necessary to prevent the concrete from adhering to them.

67.5 Curb and Gutter Joints. Expansion joints one-half (1/2) inch wide shall be constructed in curbs and gutters at thirty (30) foot intervals, and in curbs, at the ends of all returns. Expansion joints shall be filled with joint filler strips one-half (1/2) inch thick conforming to the requirements of Section 112 of these specifications. Expansion joint filler shall be shaped to the cross-section of the curb and gutter.

Weakened plane joints shall be installed at fifteen (15) foot intervals, except that when Portland cement concrete pavement is adjacent thereto, or to be constructed adjacent thereto, they shall be installed continuously with the weakened plane joints in the adjacent pavement. Weakened plane joints shall be constructed to a minimum depth of one (1) inch by scoring with a tool which will leave the corners rounded and insure a free movement of the concrete at the joint.

Expansion joints and weakened plane joints shall be constructed at right angles to the line of the curb and gutter.

67.6 Sidewalk Expansion Joints. Transverse expansion joints one-half (1/2) inch wide shall be constructed at all sidewalk returns and opposite expansion joints in adjacent curb. Where curb is not adjacent, expansion joints shall be constructed at intervals of thirty (30) feet.

Expansion joints shall be filled with joint filler strips one-half (1/2) inch thick, conforming to the requirements of Section 112 of these specifications.

The joint filler shall be placed with the top edge one-fourth (1/4) inch below the surface and shall be held in place by means of steel pins driven into the subgrade and spaced sufficiently close to prevent warping of the filler during floating. Upon completion of floating, the pins shall be removed and a suitable metal channel having legs not over three-fourths (3/4) inch long shall be fitted snugly over the joint filler. The metal channel shall remain in place until the finishing operations have been completed, after which it shall be removed and the joint edged with an edging tool having a radius of one-eighth (1/8) inch.

All concrete shall be cleaned from the joint opening after edging.

67.7 Curb and Gutter Construction. In constructing curbs, entrances shall be provided for garages or driveways to replace former facilities. The entrances shall be of the dimensions designated by the engineer, and the curb at entrances of driveways shall be finished on a slope, the back edge being one (1) inch higher than the front edge.

Type 2 curb, as shown on the plans, may be constructed of precast members, provided the members are connected together in a manner approved by the engineer, in order to maintain a true line and grade.

Where plant-mixed surfacing is to be placed around or adjacent to manholes, drop inlets or catch basins in gutter, local depression or driveway areas, such structures shall not be constructed to final grade until after the curbs and gutters have been constructed for a reasonable distance, as directed by the engineer, on each side of the structure, in order to maintain a true grade for the surfacing to match.

Where concrete pavement is to be placed around or adjacent to manholes,

drop inlets, or catch basins in gutter, local depression or driveway areas, such structures shall not be constructed to final grade until after the concrete pavement has been constructed.

Local depressions and driveways shall be constructed according to the dimensions shown on the plans.

Concrete curbs to be constructed over an existing pavement shall be anchored to the pavement by means of steel dowels firmly grouted, with 1:1 Portland cement grout, in holes drilled in the pavement. Dowels shall conform to the requirements of bar reinforcing steel of these specifications and shall be spaced and be of the size and length as shown on the plans. Approved expansion bolts may be used in lieu of dowels, at the option of the contractor.

Concrete shall be placed in the forms in layers not exceeding six (6) inches in depth. The forms shall be filled to the top and the concrete shall be so handled that there will be no rock pockets. Concrete may be compacted by means of mechanical vibrators approved by the engineer.

Prior to the removal of the forms, the surfaces shall be finished true to grade by means of a straightedge float, not less than ten (10) feet in length, operated longitudinally over the surface of the concrete. Form clamps shall be so constructed as not to interfere with the operation of this float.

Immediately after removing the front curb forms, the face of the curb shall be troweled smooth to a depth of not less than two (2) inches below the flow line or to the flow line of integral curb and gutter, and then finished with a steel trowel. The top shall be finished and the front and back edges rounded as shown on the plans.

After the face of the curb has been troweled smooth, it shall be given a final fine brush finish with brush strokes parallel to the line of the curb.

The top and face of the finished curb shall be true and straight, and the top surface of curbs and gutters shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge ten (10) feet long is laid on the top or face of the curb or on the surface of gutters, the surface shall not vary more than one-eighth (1/8) inch from the edge of the straightedge, except at grade changes or curves.

The exposed surfaces shall be cured in accordance with the requirements of Section 45 or with a non-bituminous curing compound conforming to the requirements of Section 114 of these specifications.

After curing, the backfill shall be placed as shown on the plans. The completed units shall be protected from damage.

The contractor shall clean, at his own expense, all concrete discolored during construction. When any unit requires repairs, the repairs shall be made by removing and replacing the entire unit between scoring lines.

Areas that are to be painted shall be thoroughly cleaned of all foreign material, including any curing medium, by sandblasting or other approved methods.

67.8 Sidewalk Construction. After the concrete for the sidewalk has been placed, the concrete shall be struck off to proper section and compacted with a grid of parallel metal bars until a layer of mortar not less than three eighths (3/8) inch thick has been brought to the surface. The concrete shall then be given a final tamping with a light tamper consisting of wire mesh, having square openings of not less than one-eighth (1/8) inch nor more than one-fourth (1/4) inch in size.

The surface shall then be finished to grade and cross-section with a wooden float. The wooden float shall be fifteen (15) feet to eighteen (18) feet in length, six (6) inches to eight (8) inches in width and from one-half (1/2) inch to one (1) inch in thickness with reversible handles at each end. After floating, the surface shall be troweled smooth and finished with a fine hair push broom drawn over the surface transverse to the line of traffic. Water, if necessary, shall be applied to the surface immediately in advance of brooming.

The surface of sidewalks shall be marked into rectangles of not more than twelve (12) square feet, the marking to be done with a tool which will leave the corners rounded and insure a free movement of the concrete at the joint.

When a ten (10) foot straightedge is placed on the sidewalk, the surface shall not vary more than one-eighth (1/8) inch from the edge of the straightedge, except at grade changes, and the finished surface shall be free from blemishes.

Immediately after the surface of the sidewalk is finished, the concrete shall be cured in accordance with the requirements of Section 45 or with a non-bituminous curing compound conforming to the requirements of Section 114 of these specifications.

67.9 Method of Measurement. Concrete in curbs, gutters, sidewalks, local depressions and driveways will be measured in accordance with the dimensions shown on the plans. No deduction in volume will be made for the recessed portions of the curb in computing quantities of concrete to be paid for.

67.10 Basis of Payment. The price paid per cubic yard for Class A or AA concrete curbs, gutters, sidewalks, and driveways, as individual items or any combination thereof as indicated in the proposal, shall include full compensation, except as provided below, for furnishing all labor, materials, tools and equipment and doing all the work involved in preparing the subgrade and constructing the curbs, gutters, sidewalks, local depressions and driveways complete in place as herein specified, including furnishing and placing expansion joint filler, cleaning areas to be painted and furnishing and applying paint and for furnishing and placing dowels or expansion bolts for curbs constructed over existing pavement, including drilling of holes for dowels and grouting them in place.

After the roadway prism has been completed, any excavation and backfill required will be paid for as structure excavation or structure backfill as provided in Sections 21 and 22 of these specifications.

Bar reinforcing steel placed in curbs and gutters as shown on the plans or where directed by the engineer will be paid for as provided in Section 47 of these specifications.

SECTION 68 - CONCRETE SLOPE PAVING

68.1 Description. Concrete slope paving and aprons, and concrete cut-off walls in connection therewith, shall be constructed to the lines and grades established by the engineer and in accordance with the design shown on the plans.

68.2 Subgrade Preparation. The subgrade shall be constructed true to line and grade, as shown on the plans or as directed by the engineer. It shall be thoroughly watered and rolled or tamped until hard and solid before placing the concrete. All soft or spongy material shall be removed to a minimum depth of six (6) inches below subgrade elevation, the resulting space filled with selected material, sand or gravel, and thoroughly watered and rolled or tamped until a firm foundation is secured.

68.3 Construction Methods. Concrete slope paving and aprons, and concrete cut-off walls, shall be constructed of Class A or AA Portland cement concrete, mixed and placed as provided in Sections 44 and 45 of these specifications, and shall be reinforced as shown on the plans. Reinforcing steel shall conform to the requirements of Section 47 of these specifications.

Concrete, after spreading, shall be tamped until it is thoroughly compact and mortar flushes to the surface. If the slope is too steep to permit the use of concrete sufficiently wet to flush with tamping, the concrete may be tamped until consolidated and a mortar surface one-fourth (1/4) inch thick, troweled on immediately. The mortar shall consist of one part Portland cement and three parts of clean, sharp sand. The mortar surface shall be considered as a part of the concrete and no additional allowance will be made therefor.

After striking off to grade, the concrete shall be hand floated with wooden floats not less than four (4) inches in width and not less than thirty (30) inches in length. Care shall be taken to prevent rotary marks of the hand floats. The entire surface shall be broomed with a fine texture hair push broom to produce a uniform surface and eliminate float marks. Brooming shall be done when the surface is sufficiently set to prevent deep scarring and shall be accomplished by drawing the broom down the slope leaving the marks parallel to the edges of the panel. If ordered by the engineer, a fine spray of water shall be applied to the surface immediately in advance of brooming. Joints shall be edged with a one-fourth (1/4) inch radius edger prior to the brooming.

When required by the plans, expansion joints in slope paving and concrete aprons shall be installed transversely at intervals of twenty (20) feet. Longitudinal expansion joints shall be installed where shown on the plans or ordered by the engineer.

Expansion joints shall be filled with a durable resilient expansion joint filler one-half (1/2) inch thick conforming to the requirements of Section 112 of these specifications.

Concrete slope paving shall be cured as specified in Section 67, of these specifications.

Concrete aprons and cut-off walls shall be cured as specified in Section 45, of these specifications.

68.4 Backfilling. The paving of concrete aprons and cut-off walls shall be backfilled to the original ground surface or to the elevation shown on the

plans or directed by the engineer. The surface of the backfilled material shall be left smooth and uniform.

68.5 Method of Measurement. The quantity of slope paving, aprons and cut-off walls to be paid for shall be the number of cubic yards of concrete placed therein, complete in place and accepted. The quantity will be computed from measurements of the actual areas placed based on the theoretical thickness shown on the plans. No additional allowance will be made for additional concrete placed by reason of low subgrades.

68.6 Basis of Payment. The quantity measured as provided above, shall be paid for at the contract unit price bid per cubic yard for "Class A Concrete Slope Paving," "Class AA Concrete Slope Paving," "Class A Concrete Aprons," or "Class AA Concrete Aprons," as the case may be, which payment shall be full compensation for furnishing all labor, materials, tools, supplies and equipment, and doing all the work involved in preparation of subgrade, furnishing and placing expansion joint filler, curing, and constructing the finished slope paving or aprons, including cut-off walls, as herein specified and shown on the plans, except excavation, backfill, reinforcing steel and water.

Excavation shall be measured and paid for as provided in Section 21.

Backfill shall be measured and paid for as provided in Section 22.

Reinforcement (bar or mesh) will be measured and paid for as provided in Section 47.

SECTION 69
(BLANK)

SECTION 70 - FENCING

70.1 Description. This item shall consist of furnishing all materials and erecting new standard fence or chain link fence, or reconstructing fences previously removed, in conformity with these specifications and of the types and at the points shown on the plans or ordered by the engineer.

New standard fence shall consist of galvanized barbed wire, galvanized farm fence or both fastened to wood posts or metal posts or to a combination of the two kinds of posts as shown on the standard plans.

Chain link fence shall consist of galvanized chain-link fabric attached to metal posts and fastened to a top tensioning cable and a bottom tensioning wire. The height of chain-link fences shall be as shown on the plans or designated in the special provisions.

70.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific reference to Part III is as follows:

Fence Posts and Fence Materials ..... Section 110

70.3 Construction Methods. (a) General. All trees, brush, and other obstructions which interfere with proper construction of fences shall be removed and disposed of in accordance with the requirements of Section 12 of these specifications except that no payment will be made for such work.

Fence construction operations shall be so conducted as to prevent the escape of livestock. Existing cross fences shall be connected to the new fence and corner posts with braces for every direction of strain, shall be placed at the junction with existing fences and the wire in both fences properly fastened to the posts. At bridges and cattle passes, and at culverts if shown on the plans or ordered by the engineer the new fence shall be connected to the structure in such a manner as to permit the free passage of livestock through or under the structure.

Barbed wire, farm fence, and chain-link fence fabric shall be fastened on the side of the posts opposite the highway centerline unless otherwise directed by the engineer.

(b) Standard Fencing. Standard fencing shall be designated by types as follows: Metal posts - Type A; Wood posts - Type B; Combination metal and wood posts - Type C. The type of fence construction shall be as shown on the plans and indicated in the proposal. Posts shall be firmly set or driven into the ground and spaced as indicated on the plans. Each end, corner, and gate post shall be firmly braced and shall be set in concrete when required. Posts shall be braced as indicated on the plans.

Standard fencing will be designated not only by type, but also by a symbol indicating the fencing required. Thus, (Type A-832-3B) will be used to designate a fence composed of metal posts, thirty-two (32) inch

woven wire (farm fencing) and three (3) barbed wires; (Type C-726-4B) to designate a fence composed of a combination of metal and wood posts twenty-six (26) inch woven wire and four (4) barbed wires, etc. The figures 832, etc., when they appear in the symbol correspond to design numbers set forth in the standard plan.

In general, in determining the posts spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in vertical position except in unusual locations where in the opinion of the engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground. All intervals shall be measured center to center of adjacent posts.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed. Changes in line where the angle deflection is more than fifteen (15) degrees and less than thirty (30) degrees shall be considered as alignment angles and adjacent posts shall be made fast to the angle posts by means of wire, or if such method is impracticable in the opinion of the engineer, such posts shall be braced as above specified for bracing gate, end and corner posts.

At all grade deflections and alignment angles where stresses tend to pull the posts from the ground, the fencing shall be snubbed or guyed at the critical point by means of a double strand of nine gage galvanized wire connected to each horizontal line of barbed wire or to the top and bottom of wire mesh fabric, and to a deadman weighing approximately one hundred (100) pounds, buried in the ground not less than two (2) feet. The fencing shall be pulled snug close to the ground before being snubbed or guyed.

Barbed wire and farm fence fabric (woven wire) shall be stretched taut and securely fastened to each post by means of suitable devices approved by the engineer.

(c) Chain Link Fence. All posts shall be fitted with approved tops designed so as to fit securely over the posts and carry the top of tension cable.

All posts shall be of a total length of not less than the depth of the concrete footing as shown on the plans, plus the length required above ground.

Changes in line where the angle of deflection is thirty (30) degrees or more shall be considered as corners and corner posts shall be installed.

Between posts, chain link fences shall be fastened to a bottom tension wire and a top tension cable. The bottom tension wire shall be at least seven gage galvanized ~~coil spring~~ wire of good commercial wire. The top tension cable shall be at least three-eighths (3/8) inch diameter galvanized seven strand cable conforming to the requirements of the current ASTM Designation: A122, common grade.— common coating (or Class A)

— same as now used

Line posts shall be spaced at not more than ten (10) foot intervals, measured from center to center of posts. In general, in determining the post spacing, measurements will be made parallel to the slope of the natural ground, and all posts shall be placed in a vertical position except in unusual locations where in the opinion of the engineer it would be more satisfactory to place the posts perpendicular to the slope of the ground.

All metal posts shall be set in a Portland cement concrete footing crowned at the top to shed water. Depths of footings shall be as shown on the plans.

End, corner and gate posts shall be braced with galvanized braces used as compression members and galvanized steel truss rods with drop forged turnbuckles used as tension members. Line posts, at intervals of one thousand (1000) feet, shall be braced and trussed in both directions as shown on the plans.

The fabric shall be stretched taut and securely fastened to the posts, and between posts, the top edge of the fabric shall be fastened to the top tension cable and the lower edge fastened to the bottom tension wire. Tension cable and wire shall be stretched tight with drop forged turnbuckles. The bottom tension wire shall be installed on a straight grade between posts by excavating the high points of the ground and in no case will filling of depressions be permitted.

The fabric shall be fastened to the end, corner and gate posts with one-quarter (1/4) inch by three-quarter (3/4) inch steel stretcher bars and not less than one-eighth (1/8) inch by three-quarter (3/4) inch steel stretcher bar bands placed at one (1) foot intervals; and to line posts tension cables and tension wires with tie wires or metal bands. Tie wires or metal bands shall be spaced on line posts at intervals of approximately fourteen (14) inches and on tension cables and tension wires approximately eighteen (18) inches.

(d) Reconstructed Fences. Reconstructed fences shall be carefully erected, using salvaged materials and shall be similar in type to the original construction. Any new materials necessary to rebuild the fence shall be furnished by the contractor, shall be of the same kind as those in the original fence, and the cost thereof shall be included in the contract price for the work. The resulting reconstructed fence shall be equal to or better than before removed. In reconstructed fences, the department reserves the right to furnish the contractor with such new materials as it deems advisable, and these materials shall be used in the reconstruction of the fence in lieu of salvage materials which they replaced.

(e) Gates. The width of drive gates shall be as shown on the plans and as indicated in the proposal and the height shall be suited to the fencing but shall not be more than seventy-two (72) inches nor less than forty-eight (48) inches. The wire mesh filler shall be rectangular or two (2) inch diamond mesh for standard fencing and chain-link fence fabric for chain-link fencing.

Walk gates shall be three and one-half (3-1/2) feet wide and of a height corresponding to the adjacent fence height.

The gates shall be hung by steel or malleable iron hinges so designed as to securely fasten to the gate posts and permit the gate to swing back against the fence.

Gates shall be provided with a combination steel or malleable iron catch

and locking in attachment of approved design. A center rest with catch shall be provided where required.

Missouri gates shall be constructed as shown on the standard plan.

70.4 Method of Measurement. The quantity of new fencing to be paid for shall be the number of linear feet of fence, exclusive of gates and cattle guards, measured in the completed and accepted work.

The quantity of reconstructed fencing to be paid for shall be the number of linear feet of fence, including gates, measured in place in the completed and accepted work, except that when new gates are required, the length of such gates shall be excluded.

Gates, except Missouri gates, shall be measured as units. Missouri gates shall not be measured for payment by the unit.

70.5 Basis of Payment. The quantity of fence constructed, or fence reconstructed, measured as provided above, shall be paid for at the contract unit price bid per linear foot for "Construct Type_____Fence", "Construct_____inch Chain-Link Fence", "Construct_____Fence" or "Reconstruct Fence", as the case may be.

The number of new gates installed, measured as provided above, shall be paid for at the contract unit price each for"_____ft._____ Drive Gates", or "_____ft._____Walk Gates" as the case may be. If double drive gates are placed, each single gate will be paid for at the unit price per gate.

Missouri gates shall be paid for as linear feet of fence. Payment specified above shall be full compensation for furnishing and installing gates and fence, including clearing the line of the fence and disposing of the resulting materials, excavating high points in existing ground between posts, excavating and backfilling and furnishing and placing concrete footings, connecting new fences to structures and existing cross-fences, and for all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work in place as specified.

SECTION 71 - GUARD RAIL

71.1 Description. This item shall consist of furnishing and delivering all necessary posts, steel plate beams, supports, fastenings and fittings, and preparing, assembling, setting and erecting the same; the preservative treatment, and painting of pertinent parts as required by these specifications and shown on the plans, for a completed guard rail of the type, at the locations, and to the lines and grades shown on the plans or ordered by the engineer. Where so required by the plans and proposal or ordered by the engineer, the work done under this item shall also consist of the careful dismantling, removal and re-erecting or storing (at locations specified on the project) of existing guard rail.

71.2 Materials. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform with all the requirements for such materials as set out in this specification and in Part III, Material Details. Specific references to part III are as follows:

Douglas Fir (coast or inland region)	Section 107
West Coast Hemlock	Section 107
Western Larch	Section 107
Timber Preservatives	Section 109
Guard Rail Materials	Section 111

The minimum grade of post supplied when graded under the rules prescribed in Section 107 shall be as follows:

Douglas Fir (Coast) - "Construction" - Beams & Stringers, 1500f
West Coast Hemlock - "Construction" - Beams & Stringers, 1500f
Paragraph 124-b
Douglas Fir (Inland) - Struct. Posts & Timbers - Paragraph 608 to 612 incl. & 614
Western Larch - Struct. Posts & Timbers - Paragraph 567 to 570 incl. & 572.

71.3 Construction Details. Unless otherwise specified, guard rail shall be constructed with either treated Douglas Fir, West Coast Hemlock or Western Larch posts, beam type plates, and fittings, as shown on the plans. Post spacing shall be as shown and guard rails shall be constructed in accordance with the design shown on the plans. The use of more than one type of guard rail on a single project will not be approved unless so provided in the special provisions or appearing as a contract item in the proposal.

Each post, after fabrication, shall be given a preservative treatment by pressure processes with one of the following in accordance with the provisions of Section 52:

(a) Creosote
(b) 50-50 Creosote-Petroleum
(c) 5% Pentachlorophenol

The minimum retention of preservative in pounds per cubic foot of wood shall be as follows:

(a) Creosote - 8 pounds
(b) Creosote - Petroleum - 8 pounds
(c) Pentachlorophenol - 8 pounds

In long runs of guard rail, a five (5) foot spacing shall be left between end posts at two-hundred and fifty (250) foot intervals and end sections shall be installed. In short runs or at the ends of long runs, no spacing will be required for lengths up to a maximum of four hundred (400) feet.

Posts shall be set plumb, except on superelevated curves where they shall be set perpendicular to the roadbed. Front faces of posts shall form a straight line, except on curves where they shall be a uniform distance from the center line of the roadway. Post holes shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool in such manner as not to displace the bottom of posts from correct alignment.

Workmanship shall be first-class in all respects and framing shall be done and fittings attached in such manner that the rail, after erection, shall be true to line and grade and shall have the proper tension in the rail plates. Care shall be taken to prevent the disturbance of posts during the erection of the rail, and, when necessary, temporary braces shall be installed to insure against post displacement.

Beam type rails shall be erected so that the bolts at expansion joints are located at the centers of the slotted holes.

After erection, all metal parts and fittings, free from coatings of any kind including dirt, rust, and oil or grease, shall be given three coats of paint as specified in Section 51, except that the prescribed priming coat shall be omitted on all metal parts and fittings, which have been either galvanized, or shop prime coated by the manufacturer. Galvanized parts, prior to applying paint, shall be slightly etched with a solution composed of one quart of vinegar to two gallons of water. The surface shall be rinsed with clear water and allowed to dry thoroughly before painting. Prime coat applied by the manufacturer shall be carefully handled to prevent scratching and marring and all such scratches or mars shall be spotted prior to application of specified paint. Post shall not be painted.

After the rail has been painted as specified, nuts fastening rail plate to springs shall be backed off slightly so that the connection is firm but not tight and will permit the slight movement necessary to absorb expansion and contraction of the rail.

Unless otherwise required by the plans, rebuilt units of guard rail shall be of the same type, spacing of members, etc., as original guard rail.

All salvable materials shall be removed and re-erected (or stored if so specified) with reasonable care. Posts, rails, and incidental hardware for re-erecting rail shall, in all cases, be obtained from salvage sources, but the contractor shall furnish such additional bolts, supports or incidental hardware as may be necessary to complete the guard rail.

When removal and storage is specified, the bolts, supports and other hardware shall be removed from all rails and posts and all parts shall be sorted and stored at the locations specified. Rail and posts shall be properly stacked and miscellaneous hardware shall be sacked or boxed and all such reasonable care exercised in the handling, storage and preservation of materials as will insure

the maximum salvage value for the entire operation.

All guard rail removed and re-erected shall be painted with one coat of paint (Section 51) after first touching up all spots on which the original paint has been removed or destroyed.

71.4 Method of Measurement. The quantity of new guard rail or re-erected guard rail to be paid for shall be the number of linear feet of rail, complete in place and accepted, measured along the front face of the rail between centers of end posts. In the case of new guard rail an allowance of two (2) feet at each end post shall be added to the length measured between the centers of end posts.

When the plans require that guard rail is to be removed and stored, the amount of guard rail to be paid for shall be the actual number of linear feet of guard rail (measured center to center of end posts in its original position) dismantled, sorted as to members and material and properly stacked and stored at the locations specified; provided, however, that the above number of linear feet may be reduced in proportion to the amount of unsalvable material produced in the dismantling and storing of materials.

71.5 Basis of Payment. The footage measured as provided above shall be paid for at the contract unit price bid:

Per linear foot for "Standard Steel Guard Rail" which shall be Type A as detailed in the standard plans, unless otherwise shown on the plans or set forth in the special provisions; which payment shall be full compensation for furnishing, preparing, placing and erecting all material, treating posts, inspection certificates, excavating, and backfilling, painting, end sections and for all labor, materials, tools, supplies, equipment and incidentals necessary to complete the work.

Per linear foot for "Remove and Reset Guard Rail" which payment shall be full compensation for dismantling, removing and re-erecting at locations specified and for all labor, tools, supplies, equipment and incidentals necessary to complete the work.

Per linear foot for "Remove Guard Rail" which payment shall be full compensation for dismantling, removing, handling and storing at locations specified and for all labor, tools, supplies, equipment and incidentals necessary to complete the work, provided however, that the quantities to be paid for may be reduced as provided above for producing unsalvable material in dismantling and storing.

SECTION 72 - CULVERT MARKERS AND GUIDE POSTS

72.1 Description. Culvert markers and guide posts, conforming to the details shown on the plans and the provisions of this section, shall be furnished and installed at locations indicated on the plans, directed by the engineer or as herein set forth. Reflectors conforming to the details shown on the plans shall be furnished and installed on the guide posts and culvert markers.

Unless otherwise specified in the special provisions or indicated on the plans, culvert markers and guide posts may be either timber or metal, at the option of the contractor, but only one type may be used on the project.

72.2 Materials. (a) Timber Posts. Timber posts may be either Douglas Fir, Western Larch or West Coats Hemlock and shall conform to the following grade in accordance with the provisions of Section 107:

Douglas Fir	"Standard"	Joists and Plank	1200f	Paragraph 223-e
West Coast Hemlock	"Standard"	Joists and Plank	1200f	Paragraph 223-c
Western Larch	"Structural"	Joists and Plank	Paragraph 573-580 incl.	

Douglas Fir, Western Larch and West Coast Hemlock shall be pressure treated with Tanalith (Wolman Salts), chromated zinc chloride, chromated zinc arsenate (Boliden Salt) or ammoniacal copper arsenate (Chemonite) in accordance with Section 52 of these specifications. The minimum retention shall be as follows:

Preservative	AWPA Standard	Retention lbs/cu.ft.min.	Treating Process	Max. temp.of bath ° F.
Chromated Zinc Chloride	P5	1.0	Full Cell	120
Chemonite	P5	0.5	Full Cell	150
Tanalith	P5	0.5	Full Cell	-
Boliden Salt	P5	1.00	Full Cell	120

Timber posts shall be surfaced on four sides and chamfered as shown on the plans.

(b) Metal Posts. Metal posts shall be manufactured of ten or eleven gage steel with permissable thickness variation of 0.010 inch. The posts shall be straight, shall be manufactured as one continuous piece of metal with no welded joints, and shall be free of sharp corners or rough or burred surfaces on edges.

After fabrication the post metal shall conform to the test requirement set forth in the following table:

Property	Test Method	Requirement
Elongation in 8 inches	ASTM E8	10% min.
Bend test (Room temperature)	ASTM E16	180° d = 3t
Impact requirements*	ASTM E23	25 foot pounds/ min. no cracking

*Size of speciman shall be nom. thickness x seventy five one hundreths (0.75) inch.in h.

Rev

Metal Posts shall be galvanized in conformance with the requirements of the current ASTM Designation: A123 and painting will not be required.

Target plates shall be fabricated from eighteen (18) gage steel sheet metal or heavier and shall be galvanized. If galvanized metal stock is used, it shall comply with Federal Specifications No. QQ-I-716 for Iron and Steel Sheet, Zinc Coated (Galvanized), Classes D1, D2, E1 or E2. Any of the listed classes will be acceptable. Any flaking of spelter around punched holes shall be cause for rejection. If bare metal stock is used, all items shall be hot-dipped or electro-galvanized before painting. The weight of the zinc coating shall comply with the above mentioned Federal specifications.

Prior to painting target plates, all fabrication including sheering and the punching of holes shall be done and all dirt, grease or oils shall be removed and the metal prepared by "Bonderizing" or other approved process.

One coat of an approved baking primer shall be applied to the edges and both sides of the plates. The backs and edges of the plates shall then receive one coat and the face shall receive two coats of baking enamel conforming to the Federal Specification TT-E-489, Class B, or approved equal. A final finish coat shall be applied to the face of the plates and shall consist of clear alkyd melamine or clear alkyd urea formaldehyde baking enamel.

Paint may be applied by either spraying, dipping, roller coating, or other approved method, provided the finished surfaces, including edges, are smooth and paint coats are of uniform thickness.

Each of the above coats shall have a minimum dry film thickness of 0.0005 inch when baked at a temperature of two hundred fifty (25) degrees F. for one hour. The total thickness of coating on the front face shall be a minimum of 0.002 inch and on the back face shall be a minimum of 0.001 inch.

All painting and fabricating shall be done in a workmanlike manner and shall be subject to inspection and release by the engineer before shipment from the fabricating plant.

(c) Hardware. Hardware for attaching the target plates shall consist of roundhead galvanized one-quarter (1/4) inch machine screws with "Parkerized" treatment, or equal, aluminum finished speed nuts. Washers shall be five-sixteenths (5/16) inch I.D. asbestos, not less than one thirty-second (1/32) inch thick.

(d) Reflectors. Reflectors shall be a reflectorized material of silver color such as "Scotchlite" manufactured by Minnesota Mining and Milling Company or an approved equal. The reflectorized material shall be of the design shown on the plans and shall be applied to the markers and posts after erection. The reflectorized material shall be firmly attached to the posts by means of an adhesive designed specifically for this purpose.

72.3 Construction Methods. (a) Installation. The markers and guide posts shall be spaced and erected in the manner indicated on the plans, and shall be set plumb, except on superelevated curves they shall be set perpendicular to the roadbed.

When soil conditions permit metal posts may be driven in place, provided the method of driving does not damage the posts. Metal targets shall be installed after the posts have been set in place.

Posts shall be placed in the ground to the depth shown on the plans. After the posts have been set in position, excepting metal posts that have been

driven in place, the open space around them shall be filled with earth free from rock. The filling material shall be thoroughly watered and tamped into place in such a manner as not to shift the posts from their correct position and to hold the post securely in position.

When the proposal calls for existing culvert markers and guide posts to be removed and reset, the posts in place shall be carefully removed, stockpiled if necessary, and reset at specified locations. Resetting and painting shall be as specified above.

Unless otherwise noted on the plans, guide posts shall be set according to the following data:

(1) On both sides of the roadbed at the beginning and end of each curve, at five hundred (500) foot intervals on tangents, and at four hundred (400) foot intervals on curves having a radius greater than five thousand (5000) feet.

(2) On the inside of curves at five hundred (500) foot intervals up to five thousand (5000) feet radius.

(3) On the outside of curves, the intervals between posts shall be as follows:

Radius	500'	or less	- 50'
	550'	to 1000'	- 75'
	1050'	to 2500'	- 100'
	2550'	to 5000'	- 200'

(4) Six guide posts shall be set to outline Type 1 approaches and two shall be set at Type 2 approaches.

All spacing shown above is approximate only. Posts shall be set as directed by the engineer.

No guide posts will be required on tangents where the spacing between culvert markers is less than seven hundred fifty (750) feet, or in cuts having backslopes steeper than four to one (4:1).

(b) Painting. Guide post and culvert markers shall be painted in accordance with Section 51 of these specifications.

Painting of galvanized posts will not be required.

Target plates shall be painted as specified under Article 72.2, sub-article (b) of this section.

Timber posts shall be given one coat of wood primer and two coats of finish paint for wood conforming to the provisions of Section 51, and paint shall be applied over a sufficient area to provide a painted surface that will extend at least six (6) inches below the ground surface.

The tops of the markers and guide posts shall be painted black as shown on the plans. Black paint shall conform to the requirements of Section 51.

Before completion of the contract, all areas where the paint has been damaged shall be given a spot coat of paint and all exposed areas that have become

soiled shall be cleaned or repainted, and no additional compensation will be allowed for such work.

72.4 Basis of Payment. The contract unit price paid for Culvert Markers or Guide Posts, or any combination thereof as indicated in the Proposal, shall include full compensation for furnishing all labor, materials, tools, supplies and equipment, and doing all the work involved in furnishing and installing the guide posts or culvert markers complete in place as specified. No additional compensation will be allowed for furnishing treated Douglas Fir or treated Western Larch post.

When called for, the number of culvert markers and guide posts removed and reset, complete in place and accepted shall be paid for at the contract unit price bid each for "Remove and Reset Culvert Markers and Guide Posts", which payment shall be full compensation for removing the posts, stockpiling if necessary, painting and resetting them in accordance with this specifications, and for all labor, equipment, materials, supplies, tools, and incidentals necessary to complete the work specified, including excavation, backfill and disposal of surplus materials.

SECTION 73
(BLANK)

SECTION 74 - RIGHT OF WAY MARKERS

74.1 Description. This item shall consist of furnishing all materials and erecting timber posts for right-of-way markers conforming to these specifications and of the design shown on the plans and at points indicated herein or ordered by the engineer.

74.2 Materials. The posts shall be either treated Douglas Fir, treated Western Larch or treated West Coast Hemlock, conforming to the requirements of Section 72.

Douglas Fir, Larch and Hemlock shall be given a preservative treatment by pressure processes in accordance with the requirements of Section 72.

74.3 Construction Methods. Right-of-way markers shall be erected to define the right of way lines and, unless otherwise specified shall be set at beginning and end of each project, at beginning and end of each curve, and at all corners or irregular right-of-way lines, and approximately one-half (1/2) mile apart on long tangents. Right-of-way markers shall be set plumb and the post hole shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool.

74.4 Measurement and Payment. The number of right-of-way markers in the completed and accepted work shall be paid for at the contract unit price each for "Right-of-Way Markers", which price shall be full compensation for furnishing, erecting, treating and painting the posts, for inspection certifications, and for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, including excavation and backfill.

SECTION 75 - MONUMENTS

75.1 Description. This item shall consist of constructing Portland cement concrete monuments of the design and at the locations indicated on the plans or directed by the engineer and installing a metal marker post adjacent to each monument as shown on the plans.

75.2 Materials. All materials shall conform to the requirements of Part III, Material Details. Specific references to Part III are as follows:

Water	Section 80
Coarse Aggregate for Portland Cement Concrete	Section 85
Fine Aggregate for Portland Cement Concrete	Section 88
Portland Cement	Section 96

Bronze disks will be furnished by the department.

75.3 Construction Methods. Monuments shall be constructed of Portland Cement Concrete, in accordance with the applicable provisions of Section 45, "Concrete Structures." The class of cement concrete to be used shall be as shown on the plans or set forth in the Special Provisions.

These monuments shall be set to assist in reestablishment of the centerline for future use and shall be set at the beginning and end of each project, at the beginning and end of each curve, and approximately one-half (1/2) mile apart on long tangents.

These monuments located as outlined above, shall be established outside construction limits, and the exact location will be that determined by the engineer.

A hole just large enough for the monument shall be excavated for the required depth. If solid rock is reached before the required depth is reached the monument may be built on this instead of being built to its full depth. This hole shall be filled with the cement concrete. When the concrete has set sufficiently the bronze disk or a plug shall be installed in the exact position required by the engineer.

Metal marker posts shall be "T" rail steel drive fence posts complete with an anchor and not less than five (5) feet in length, weighing not less than one and three tenths (1.3) pounds per foot. The posts shall be galvanized or painted with anti-corrosive paint. The posts shall be driven to the depths indicated or ordered and shall be located adjacent to the monument.

75.4 Method of Measurement and Basis of Payment. This work shall be paid for at the contract unit price each for "Reference Monuments" complete in place, which price shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work, including excavation, backfill disposal of surplus excavated material and the furnishing and installation of the metal marker posts.

SECTION 76 - RAISED TRAFFIC BARS

76.1 Description. This item shall consist of furnishing traffic separator bars (precast or extruded-in-place) conforming to the details and dimensions shown on the plans and to the requirements herein specified, and installing said bars at the locations shown on the plans or as directed by the engineer.

76.2 Materials. The traffic bars shall be constructed of material that will conform to the physical requirements listed below and shall be light in color.

When required by the engineer, traffic bars shall be sampled and tested and shall conform to the following requirements:

Flexure breaking load (air cured conditions)	300 pounds min.
Compressive strength (air cured conditions) (7 days)	1,000 pounds min.
Abrasion Loss (air cured conditions)	10% max.
Abrasion Loss (after soaking in water at room temperature for 24 hours)	10% max.
Absorption, 24 hours in cold water	10% max.

Extruded traffic bars shall be manufactured and placed by an approved automatic machine where Portland cement concrete is extruded under pressure through metering gates and a bar forming chamber. The aggregates shall be so graded and proportioned and thoroughly mixed in an approved mixer with such proportions of cement and water as will produce a homogeneous concrete mixture that the extruded traffic bars will conform to the test and design requirements of these specifications. In no case, however, shall the proportion of Portland cement in the mixture be less than six U.S. standard (94 lb.) bags per cubic yard of concrete. There shall be no slump.

76.3 Installation. The area where the bars are to be placed shall be thoroughly cleaned of all dust, dirt, and debris and loose material.

The bars shall be set firmly or extruded in place on the finished surfacing with an approved adhesive in accordance with the directions of the manufacturer. Each precast bar shall fit the surface with reasonably uniform bearing and all excess adhesive material shall be squeezed out from under the bar.

Extruded-in-place bars shall be carefully trimmed and finished to the required shape and dimensions and thoroughly finished to present a neat and workmanlike job.

After the bars are placed and thoroughly bonded to the surface they shall be painted as follows:

(a) Precast bars shall be painted with masonry paint as specified in Section 51.

(b) Extruded bars shall be painted within thirty (30) minutes after placing with a mixture composed of white Portland cement and water mixed to a thick cream consistency. After the white Portland cement application has set, the bars shall receive a uniform application of white pigmented liquid curing compound.

76.4 Method of Measurement. Raised traffic bars shall be measured in linear feet, along the axis of each bar complete in place.

76.5 Basis of Payment. Raised traffic bars measured as provided above shall be paid for at the contract unit price bid per linear foot for "Raised Traffic Bars", which shall be full compensation for furnishing, placing and painting the traffic bars as above specified, for furnishing all labor, materials, tools, supplies, equipment and in incidentals necessary to complete the work.

77.1 Description. The work to be done consists of furnishing and installing all necessary materials and equipment to complete in place traffic signal, highway lighting, and other electrical systems and also of modifying existing systems, all as shown on the plans and as specified in the following specifications.

Included in the work is the furnishing and installing of traffic signal control equipment, signal heads, pedestrian push buttons, vehicle detectors, posts, poles, pedestals, standards, luminaires, sign lighting fixtures, beacons, isolating transformers, series to multiple transformers, ballasts, cut-outs, service switches, service circuit breakers, photoelectric controls, meter sockets, electrical conduits, fittings, conductors, pull boxes, sumps, and all materials necessary for operating and controlling the traffic signal, highway lighting or other electrical systems, as specified herein, in the special provisions, or as shown on the plans.

Unless otherwise indicated on the plans or specified in the special provisions, all materials shall be new.

Where existing systems are to be modified, the existing material shall be incorporated in the revised system, salvaged, or abandoned, as specified in the special provisions, or as ordered by the engineer.

Foundation excavations are to be made and backfilled; concrete foundations are to be constructed; and all improvements and equipment disturbed, damaged, or removed in performing the work, are to be removed and replaced or repaired.

The location of signals, controllers, electroliers, illuminated signs, and appurtenances shown on the plans are approximate and the exact location will be established by the engineer in the field.

All incidental parts which are not shown on the plans, or specified herein, and which are necessary to complete the traffic signal, highway lighting, or other electrical systems or required for modifying existing systems, shall be furnished and installed as though such parts were shown on the plans or specified herein. All systems shall be complete and in operation to the satisfaction of the engineer at the time of completion of the work.

77.2 Regulations and Code. All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA) or the Radio Manufacturers Association, whichever is applicable. In addition to the requirements of these specifications, the plans and the special provisions, all material and work shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code; the Rules for Overhead Electric Line Construction, of the Public Service Commission; the Standards of the American Society for Testing Materials (ASTM); the American Standards Association (ASA): and any local ordinance which may apply.

Wherever reference is made, in these specifications or in the special provisions to the Code, rules, or the standards mentioned above, the reference shall be construed to mean the code, rule, or standard that is in effect at the date of advertising of these specifications.

77.3 Equipment List and Drawings. Within 10 days following notification of award of the contract, the contractor shall submit to the engineer for approval, a list

of equipment and material which he proposes to install, which shall include all material which is identified on the plans or in the specifications by the manufacturer's name which is necessary or customary in the trade to identify such materials. The list shall be complete as to name of manufacturer size and catalog number of unit, and shall be supplemented by such other data as may be required, including detailed scale drawings and wiring diagrams of any nonstandard or special equipment and of any proposed deviation from the plans. If required to do so, the contractor shall submit for approval, sample articles of the material proposed for use. All of the above data shall be submitted in duplicate for checking, and following checking, correction, and approval, not less than three (3) complete sets shall be submitted to the engineer. The department will not be liable for any material purchased, labor performed, or delay to the work prior to such approval.

Upon completion of the work, the contractor shall submit an "As Built" or corrected plan, or any data therefor as required by the engineer, showing in detail all construction changes, especially location and depth of conduit and completed schematic circuit diagram.

77.4 Materials and Installation. (a) Excavating and Backfilling. The excavations required for the installation of conduit, foundations, and other appliances shall be performed in such a manner as to cause the least possible injury to the streets, sidewalks, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appliances and foundations. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be placed in a position where the least interference with the surface drainage will occur.

All surplus excavated material shall be removed and disposed of within forty-eight (48) hours, by the contractor, outside of the highway right-of-way. Unless otherwise provided, the contractor shall make his own arrangements for disposing of materials outside the right-of-way and shall pay all costs involved therewith.

The excavations shall be backfilled in conformance with the requirements of Section 22 of these specifications.

Excavations after backfilling, shall be kept well filled and maintained in a smooth and well-drained condition, until permanent repairs are made.

At the end of each day's work and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic.

All excavation shall be closed, and sidewalks, pavement and landscaping restored at each intersection prior to opening any other intersection, unless it is otherwise approved by the engineer.

Excavations in the street or highway when such street or highway remains open to public traffic, shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time.

(b) Removing and Replacing Improvements. Improvements such as sidewalks, cubs, gutters, Portland cement concrete and asphalt concrete pavements, bituminous surfacing, base material, and any other improvements removed, broken or damanged by the contractor shall be replaced or reconstructed with the same kind of materials as found on the work or with materials of equal quality. The

new work shall be left in a serviceable condition satisfactory to the engineer.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as above specified.

The outline of all areas to be removed in portland cement concrete sidewalks and in pavements shall be cut to a minimum depth of one and one-half (1-1/2) inch with an abrasive type saw prior to removing the sidewalk and pavement material. Cut for remainder of the required depth may be made by a method satisfactory to the engineer. Cuts shall be neat and true with no shatter outside the removal area.

(c) Foundations. Foundations for posts, standards, and pedestals shall be Class AA portland cement concrete, conforming to the applicable requirements of Sections 44 and 45 of these specifications, except as herein provided.

Concrete for the installation of detectors shall be Class DA portland cement concrete, or Class AA portland cement concrete with Type III cement used in lieu of Type II cement. Type III cement shall conform to the provisions of the current ASTM Designation: C150. Aggregate shall be three-fourths (3/4) inch maximum size.

In placing concrete foundations for detectors, concrete shall be worked up between the channels by mechanical vibrating methods. The detector pad shall be removed and a three-fourths (3/4) inch inspection hole shall be provided at one (1) foot intervals, placed uniformly along each side of the center line of the pan. Detector frame and concrete shall be finished flush and true with the pavement surface.

The bottom of concrete foundations shall rest on firm ground.

Foundations shall be poured "in the solid" and monolithically where practicable. For posts, standards, and pedestals, the top two (2) inches shall be poured after the post, standard, or pedestal is in proper position. The exposed portions shall be formed to present a neat appearance.

Forms shall be true to line and grade. Tops of footings for posts and standards, except special foundations, shall be finished to curb or sidewalk grade or as ordered by the engineer. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position and to proper height, and shall be held in place by means of a template until the concrete sets.

Anchor bolts shall conform to the specifications of the current ASTM Designation: A307 and shall be provided with two nuts and two washers each. Plumbing of standards shall be accomplished by adjusting these nuts before the foundation is finished to final grade. Shims, or other similar devices for plumbing or raking will not be permitted.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

Ordinary Surface Finish prescribed in Section 44 shall be applied to exposed surfaces of concrete.

Where obstructions prevent construction of planned foundations, the contractor shall construct an effective foundation satisfactory to the engineer.

(d) Standards and Posts. Standards and posts for traffic signals, electroliers, cabinets, illuminated signs, etc., shall be as specified in the special provisions or shown on the plans and shall conform to the applicable provisions of Section 48 of these

specifications and to the following requirements:

(1) Type I standards shall be used for post-top mounting of traffic signals as shown on the plans. Mounting height shall not be less than ten (10) feet, except for special conditions shown on the plans. Type I standard shall be constructed of No. 11 or heavier U.S. gage steel, with the top designed for post-top slip-fitter.

Type II standards shall be used for mast-arm mounting of traffic signals without luminaires and with or without bracket-mounted traffic signals.

Type III standards shall be used for mast-arm mounting of both luminaires and mast-arm traffic signals and with or without bracket-mounted traffic signals.

TypeIIV standards shall be used for mast-arm mounting of luminaires with or without bracket-mounted traffic signals.

(2) Unless otherwise specified on the plans or in the special provisions, Types II, III, and IV standards shall conform to the details shown on the plans and the following specifications:

Standards shall be fabricated from (A) sheet steel conforming to the specifications of the current ASTM Designation: A245, Grade C, or from (B) sheet steel of weldable grade. If alternate (B) is used, the steel after fabrication, shall have a minimum yield of forty thousand (40,000) pounds per square inch.

Standards with one mast arm shall be fabricated of not less than No. 10 U.S. gage steel except that when material conforming to (B) above is used, the gage shall not be less than No. 11 U.S. gage steel.

Type III standards with both signal and luminaire mast arms shall be fabricated of not less than No. 7 U.S. gage material.

Standards shall be fabricated of full length sheets or of sections not less than ten (10) feet in length (except the five (5) foot section added for the thirty-five (35) foot standards).

Each section shall be fabricated from not over two pieces of sheet steel. Where two pieces are used, the longitudinal welded seams shall be directly opposite one another. When the sections are butt welded together, the welded seams on adjacent sections shall be placed to form continuous straight seams from base to top of standard.

Standards shall be straight, with a permissive variation not to exceed one (1) inch measured at the midpoint of a thirty (30) foot or thirty-five(35) foot standard and not to exceed three-fourth (3/4) inch measured at the midpoint of a twenty (20) foot standard.

A maximum static deflection of four (4) inches, without wind load, will be permitted for poles not over thirty (30) feet in height and four and one-half (4-1/2) inches for poles thirty-five (35) feet in height. Static deflection shall be measured with the mast arms, luminaires or signals or both in place.

Mast arms shall be fabricated from standard pipe, well reamed, free from burrs, and without intermediate splices or couplings, curved to the dimensions shown on the plans and shall be provided with raintight connections to shafts.

Tie rods for mast arms shall be manufactured of structural steel conforming to the current ASTM Designation: A7 and shall be provided with two nuts and two lock washers at

each end.

Workmanship and finish shall be equal to the best general practice of modern metal fabrication shops.

The twenty (20) foot standard shall conform to the dimensions of the upper two sections of the standard shown on the plans.

The thirty-five (35) foot standard (unless fabricated from full length sheets) shall consist of the thirty(30) foot standard shown on the plans, with an additional five (5) foot tapered section three-sixteenth (3/16) inch thick (eight (8) inches O.D. to eight and eleven-sixteenth (8-11/16) inches O.D.) butt welded to the lower end of the thirty (30) foot standard.

The butt welded transverse joints shall be strengthened by inserting a metal sleeve at each joint. The sleeve shall be No. 10 U.S. gage metal and made from steel having the same chemical composition as the steel in the standard. The metal sleeve shall have a minimum length of one (1) inch. The sleeve shall be centered at the joint, and have the same taper as the standard so the outside of the sleeve is in full contact throughout its length and circumference.

All welds shall be continuous.

The weld metal at the transverse joint shall extend to the sleeve, making the sleeve an integral part of the joint.

All longitudinal welds shall be performed by the submerged arc process.

All exposed welds except fillet welds, shall be ground flush with the base metal.

All exposed edges of the plates which make up the base assembly shall be finished smooth and all exposed corners of such plates shall be neatly rounded to one-eighth (1/8) inch radius unless otherwise shown on the plans. Shafts shall be provided with slip-fitter shaft caps.

(3) Standards and posts for controller cabinets, (except where noted otherwise) shall be constructed ~~at~~ of four (4) inch standard pipe, conforming to the dimensions shown on the plans.

(4) When pedestrian push buttons are to be installed on posts in lieu of attaching to adjacent traffic signal standards, the posts shall be constructed of two and one-half (2-1/2) inch standard pipe conforming to the dimensions shown on the plans.

(5) Standards for post-mounted signs shall be fabricated of steel pipe with sections swaged and welded as shown on the plans. Each standard shall be provided with a three (3) inch by five (5) inch handhole with cover plate. Sign frames for mounting signs on posts shall be fabricated of standard structural angles welded as shown on the plans. Frames shall be made to present true flat rectangular surfaces for mounting sign panels. All welding shall be done by qualified welders in conformance with the applicable specifications of the American Welding Society. A tolerance of one-thirty-second (1/32) inch shall be maintained in the positioning of holes to be used for mounting sign panels.

(6) Bridges for illuminated signs shall be as specified in the special provisions, or as shown on the plans, or both.

(7) Guard posts shall be constructed of standard pipe, eight (8) inches in diameter and five (5) feet six (6) inches long. Posts shall be set three (3) feet in a block of Portland cement concrete, as shown on the plans, and shall be filled with Portland cement concrete.

(8) Standards, sign frames, sign bridges, and fittings shall be cleaned before priming, as specified in Section 51 "Painting". Standards for traffic signals, highway lighting, and illuminated signs shall be galvanized after fabrication by the hot-galvanized process conforming to the current ASTM Designation: A123. After erection, all outside surfaces shall be cleaned free of dust, grease, and oil and all abraded and damaged areas shall be neatly soldered over with 50-50 solder.

Tie-rods, nuts, washers, and other miscellaneous ferrous parts shall be galvanized after fabrication by the hot-dipped process conforming to the current ASTM Designation: A153.

Not less than ten (10) inches of the upper end of the anchor bolts and all nuts shall be galvanized after fabrication by the hot-dipped process specified above, or cadmium plated with Type NS coating conforming to the current ASTM Designation: A165. After galvanizing or plating, the bolt threads shall accept galvanized or plated standard nuts without requiring tools or causing removal or protective coating.

(9) Posts, poles, standards, and pedestals except concrete pedestals cast in place, shall not be erected until the foundation has set at least seventy-two (72) hours, and shall be plumbed or raked, as ordered by the engineer.

(e) Conduit. All conductors shall be run in conduit except where run inside poles. Conduit to be installed underground, on the surface of poles, or in structures shall be rigid metal type, conforming to Article 346 of the Code.

Where signal conductors are run in lighting standards containing high voltage street lighting conductors, the signal conductors shall be encased in flexible or rigid metal conduit. Where telephone circuits are extended into controller pedestals, the telephone conductors shall be encased in flexible metal conduit.

Exterior and interior surfaces of all conduit and fittings shall be uniformly and adequately zinc coated by the hot-dipped galvanizing process specified above. The interior as well as the exterior of a six (6) inch sample cut from the center of a standard length of conduit when tested in accordance with the applicable portions of the current ASTM Designation: A239 shall not show a fixed deposit of copper after four (4), one (1) minute immersions in the standard copper sulphate solution.

The interior of the conduit shall have a continuous coating of lacquer or enamel. Each length shall bear the label of Underwriters' Laboratories, Inc. Installation shall conform to appropriate articles of the Code.

The size of conduit used shall be as shown on the plans. Conduits smaller than one (1) inch electrical trade size shall not be used, unless otherwise specified, except that grounding conductors at service points may be enclosed in one-half (1/2) inch diameter conduit.

Where pull boxes are installed adjacent to standard base, conduit installed

between pull box and base shall not be less than one and one-half (1-1/2) inches in diameter, unless shown otherwise on the plans.

It shall be the privilege of the contractor, at his own expense, to use larger size conduit if desired, and where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. No reducing couplings will be permitted.

The ends of all conduits shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. The threads on all conduit shall be well painted with a good quality of lead or rust preventive paint, before couplings are made up. All couplings shall be screwed up until the end of the conduits are brought together, so that a good electrical connection will be made throughout the entire length of the conduit run. Where coating on conduit has been injured in handling, or installing, such injured places shall be thoroughly painted with rust preventive paint.

All conduit ends shall be threaded and capped with standard pipe caps until wiring is started. When caps are removed, the threaded ends shall be provided with approved conduit bushings.

Conduit stubs from electrolier base shall extend at least six (6) inches from face of foundation and at least eighteen (18) inches below top of foundation. Conduit stubs on structures shall be as shown on the plans.

Conduit stubs, caps, and exposed threads shall be painted with rust-preventive paint.

The location of ends of all conduits in structures, or terminating at curbs, shall be marked by a "Y" at least three (3) inches high cut into the face of curb, gutter, or wall, directly above the conduit.

Conduit bends, except factory bends, shall have a radius of not less than six (6) times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using the longest radius practicable.

Conduit shall be laid to a depth of not less than eighteen (18) inches below the curb grade in the sidewalk areas and to a depth of not less than twenty-four (24) inches below the finished grade in all other areas, except that conduit may be laid on top of and secured to the existing pavement in curbed dividing strips. Conduit under railroad tracks shall be not less than twenty-four (24) inches below bottom of tie.

Conduit shall be placed under existing pavement by approved jacking or drilling methods. Pavement shall not be disturbed without the approval of the engineer and then only in the event obstructions are encountered. Upon approval of the engineer, small test holes may be cut in the pavement to locate obstructions. Jacking or drilling pits shall be kept two (2) feet clear of the edge of any type of pavement wherever possible. Excessive use of water such that pavement might be undermined, or subgrade softened, will not be permitted.

Conduit terminating in standards or pedestals shall extend approximately two (2) inches above the foundation vertically and shall be sloped towards hand-hole opening conduit entering concrete pull boxes shall terminate two (2) inches inside the box wall and not less than two (2) inches above the bottom, and shall be sloped to facilitate pulling of cable. Conduit entering through the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run.

Conduit entering controller cabinets shall be sealed to prevent the entrance of gases, by the use of paraffin or other approved sealing compound, as determined by the engineer.

Conduit leading to soffit, wall or other lights or fixtures below the grade of the pull box shall be sealed by means of an approved sealing fitting and sealing compound, to prevent water from flowing to the fixture.

A No. 12 AWG galvanized pull wire shall be installed in all conduits which are to receive telephone conductors or other future conductors. At least two (2) feet of pull wire shall be doubled back into the conduit at each termination.

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel and blown out with compressed air.

Conduit runs shown on the plans are for bidding purposes only and may be changed with approval of the engineer to avoid underground obstructions.

(f) Pull Boxes. Pull boxes shall be installed at the locations shown on the plans, and at such additional points, as ordered by the engineer, when runs are more than two hundred (200) feet. The contractor may install, at his own expense, such additional pull boxes that may be desired to facilitate the work.

Pull boxes and extensions shall be precast reinforced concrete boxes of the sizes and details shown on the plans. Reinforcement shall be three-fourths (3/4) inch mesh, No. 20 U.S. gage, hardware cloth or bar reinforcement. Where isolating transformers are installed in pull boxes, the No. 5 box shall be extended as shown on the plans. For signal systems, or combined signal and low voltage lighting systems, reinforced concrete covers shall be inscribed "Traffic Signals" and for lighting systems, reinforced concrete covers shall be inscribed "Street Lighting"("High Voltage," where applicable.) Covers shall be provided with two (2) three-eights (3/8) inch brass hold-down bolts with brass washers and nuts. Nuts shall be recessed below the surface of cover.

Where pull boxes are to be placed in areas subject to traffic loads, a steel cover of suitable design to withstand such loads, shall be used in lieu of the concrete cover.

Pull boxes shall be installed so that the covers are level with curb or sidewalk grade, or level with the surrounding ground when no grade is established.

The bottom of box shall be bedded in concrete or crushed rock as shown on the plans or as ordered by the engineer.

Pull boxes for structure installations shall conform to the dimensions and locations shown on the plans. Boxes or vaults formed in the concrete shall have metal frames and covers, with wording inscribed on the covers as shown on the plans. All

metal parts shall be hot-dipped galvanized conforming to the applicable portions of the current ASTM Designation: A153, after fabrication. Gasket surfaces shall form a true plane. Gaskets shall be of one piece neoprene, one-eighth (1/8) inch thick, and shall cover the contact surface between the frame and cover.

(g) Expansion Fittings. Expansion fittings, as detailed on the structure plans, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a bonding jumper of No. 6 AWG, copper wire, or equal.

(h) Conductors and Cable. Conductors and cable shall conform to the applicable specifications as follows:

(1) Traffic control conductors and multiple circuit lighting conductors shall be designed for 600 volts.

Conductors (unless otherwise specified) shall be single conductor, solid or stranded copper of gage as shown on the plans, insulated with TW grade plasticized polyvinyl chloride compound. Copper wire shall conform to the applicable portions of the current ASTM Designations: B3 and B8.

The thickness of insulation shall be four-sixty-fourths (4/64) inch for Nos. 14 to 9 AWG, inclusive, and five-sixty-fourths (5/64) inch for No. 8 AWG or larger. The insulation shall conform to the applicable portions of the current ASTM Designation: D734. Telephone interconnection conductors shall be No. 16 AWG, 19-strand conductors insulated with three-sixty-fourths (3/64) inch plasticized polyvinyl chloride compound equivalent to TW grade, conforming to the applicable portions of the current ASTM Designation D734.

(2) Multi-conductor cables shall be used only when specified in the special provisions or approved by the engineer.

(3) Conductors for series highway lighting shall be No. 8 AWG, solid or stranded copper insulated with ten-sixty-fourth (10/64) inch TW grade plasticized polyvinyl chloride compound, or equal, conforming to applicable portions of the Current ASTM Designation: D734, and designed for operation at 5,000 volts.

Series lighting conductors shall be tested in conformance with the requirements set forth in the Insulated Power Cable Engineer's Association "General Specifications for Wire and Cable with Rubber and Rubber-like Insulation," February, 1951, Section 7.7--Specifications for "Series Lighting Wire and Cable With Thermoplastic Synthetic Insulation, 3,000 and 5,000 Volt Service."

Where isolating transformers are used, the secondary conductor from transformer to luminaire shall be No. 10 AWG, or larger, conforming to specifications for 600 volts.

(4) For traffic signal and multiple circuit street lights and signs insulation shall be of solid color, or of basic colors with a permanent colored stripe, to identify conductors as detailed in the following table, unless otherwise specified.

COLOR AND STRIPE CODE OF WIRING

Code letter	Circuit	Phase or function	A.W.G. number	Conductor colors	Stripe
(S)	Lights: Signal	A	14	Red, Yellow, Green	Black
		B	14	Red, Yellow, Green	White
		C	14	Red, Yellow, Green	None
		D or Special	14	Red, Yellow, Green	Orange
(D)	Detectors:	A	12	Blue	Black
		B	12	Blue	White
		C	12	Blue	None
		D or Special	12	Blue	Orange
		Common	12	White	Black
(P)	Pedestrian Buttons	A	14 or larger	Blue	Black
		B	14 or larger	Blue	White
		C	14 or larger	Blue	None
		D	14 or larger	Blue	Orange
(F)	Flashers:	- -	14 or larger	Black	None
(L)	Lights: Street	- -	10 or larger	Black	None
	Sign		14 or larger	Black	None
(X)	Service (Any)	- -	10 or larger	Black	None
(N)	Neutral - All Circuits: (Except detector and pedestrian button commons)	- -	14 or larger	White	None
(I)	Interconnection:	Common	16 (Telephone)	White	None
			14 or larger (120-Volt)	White	None
		Resets	16 (Telephone)	Orange	None
			14 or larger (120-Volt)	Orange	None
(Y)	Spare	- -	14 or larger	Black	None

(i) Wiring. Wiring shall conform to appropriate articles of the Code. Wiring within cabinets, junction boxes, etc., shall be neatly arranged and laced.

Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit.

All signal light conductors, except branch neutrals, shall be run continuously from a terminal block located in a cabinet, compartment or signal head, to a similarly located terminal block, without splices. Branch signal light neutrals and detector commons may be spliced at pull boxes.

Sufficient signal light conductors shall be provided to perform the functional operation of the signal system and, in addition thereto, two spare conductors of size equal to the largest signal light conductor in the run, shall be provided throughout the signal light system, except as noted on the plans. At least five (5) feet of slack shall be left for each conductor at each standard (signal or lighting or combined), and at least two (2) feet of slack at each pullbox.

Where pressure detectors are to be installed, a separate hot conductor shall be run from the controller cabinet to each detector element. A common neutral conductor, separate from the signal light circuit neutral, shall be used for all 12-volt circuits, including the pressure detector and pedestrian push-button circuits.

Where isolating transformers are not to be used, series lighting cable shall be run without splices from luminaire to luminaire and from service to luminaire. Multiple lighting conductors may be spliced in bases of standards or pullboxes adjacent thereto.

Conductors shall be jointed by a "Western Union" type splice or by the use of an approved connector. Connectors shall be used for splicing all conductors No. 8 AWG, or larger. All splices shall be soldered by the pouring or dipping method.

Conductor insulation shall be well penciled, trimmed to conical shape, and roughened before applying splice insulation. Splice insulation shall consist of layers of thermoplastic electrical insulating tape not over seven thousandths, (0.007) inch thick conforming to Federal Specifications: MIL-I-7798, applied to a thickness equal to and well lapped over the original insulation, except that on high voltage and multiple lighting conductor splices, two layers of synthetic oil resistant rubber tape conforming to the requirements of the current ASTM Designation: D119 shall be applied over the conductor before placing the thermoplastic tape. The splice shall then be well covered with at least two layers of asphaltic impregnated open mesh fabric tape, and a coating of high grade insulating paint or similar material. At least two (2) feet of slack shall be left for each conductor at each splice.

Where multi-conductor cable is used, all conductor splices shall be neatly cabled together and covered with a hot vulcanized layer of material suitable to bond with the cable covering, and when finished, the joint shall present a covering built up level with original cable covering and shall be completely waterproof. An approved type of water-tight splicing box may be used in lieu of vulcanizing.

When conductors and cables are pulled into the conduit, all ends of conductors and cables shall be taped to exclude moisture, and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped.

A small permanent band or bands, on which the circuit, designation number, and phase are stamped, in the order named, using the code letters given in article (h) of this chapter, shall be securely attached near the end of each conductor, at each controller, switch, standard, or pull box, where conductors are separated. Where circuit and phase are not clearly indicated by conductor insulation, additional bands shall be used.

(j) Bonding and Grounding. Metallic cable sheaths, conduit and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strap of the same cross-sectional area, as No. 6 AWG, for series lighting systems and No. 8 AWG for all other systems.

Bonding of standards and pedestals shall be by means of a bonding strap attached to an anchor bolt or a three-sixteenth (3/16) inch, or larger, brass or bronze bolt installed in the lower portion of the shaft.

One side of secondary circuit of series-multiple transformers shall be grounded.

Grounding of conduit and neutral at service point shall be accomplished as required under the code of this section, except that grounding conductors shall be No. 6 AWG, or equal.

At each multiple service point, a ground electrode shall be furnished and installed. Ground electrodes of steel or iron shall be one piece lengths of galvanized rod or pipe at least three-fourths (3/4) inch in diameter. Electrodes of non-ferrous materials, or their approved equivalent, shall be not less than one-half (1/2) inch in diameter. Ground electrodes shall be installed in accordance with the Code. The service quipment shall be bonded to the ground electrode by use of a ground clamp and No. 6 AWG copper wire, or equal, enclosed in a one-half (1/2) inch diameter conduit or hardwood molding.

Where conduit system parallels, or crosses, a permanent water system in accessible areas, grounding jumpers shall be installed at intervals not exceeding five hundred (500) feet. Grounding to a water system at or near the service point will be accepted in lieu of the driven ground rod.

(k) Service. Service points shown on the plans are approximate only. The contractor shall determine exact locations from the serving utility.

Where the contractor is required to install the lower section of riser on a utility pole, the location of riser shall be determined by the utility.

The contractor shall furnish and install conduit and conductors to the service points as shown on the plans. Conduit for multiple lighting or traffic signal service shall not be less than one (1) inch size. Conduit for series lighting service shall not be less than one and one-half (1-1/2) inches in size.

Service fittings for multiple lighting or traffic signal systems or both

shall include a two-wire or three-wire solid neutral, 120- or 120/240- volt, service circuit breaker or service switch, in a raintight housing together with a safety socket box or meter socket or both located as specified by the power serving utility and as specified in the special provisions or shown on the drawings. Each service switch or service circuit breaker shall be provided with hasp for a padlock. The padlocks will be furnished by others.

For series lighting service, a galvanized cast iron or No. 16 U.S. gage sheet steel cut-out box not less than thirteen (13) inch by twenty-four (24) inch by sixteen (16) inch fitted with one plug cut-out for each series circuit shall be furnished and installed. Plug cut-out shall be rated 20 amperes continuous for five thousand (5,000) volt circuit and shall short circuit the feed side of the series circuit prior to opening the load contacts. The cut-out shall be operable by removing the cover by means of a hook stick.

Minimum flash-over values of cut-out shall be as follows:

Contacts to ground	40,000 volts
Load to line contacts, plug removed . . .	32,000 volts
Contact to hand groove in plug	30,000 volts
Across plug separators, with plug inserted	10,000 volts

The cut-out box shall be fitted with a cover permanently inscribed "Danger-High Voltage." The cover shall be attached to the box to form a raintight plate and shall require tools for removal. Cut-out box shall be installed not less than eight (8) feet above the ground.

Upon request of the contractor, the engineer will arrange with the serving utility to complete service connections and the contractor shall pay all costs and fees therefor.

Upon request of the contractor, the engineer will arrange for furnishing electrical energy. Energy used prior to completion of the contract will be charged to the contractor except that the cost of energy used for public benefit when such operation is ordered by the engineer, will be borne by the state.

(l) Sign Switches. Each illuminated sign installation shall be provided with a disconnect switch mounted on the sign standard or structure, as shown on the plans. Where the sign lighting is served from a series lighting system through a series-multiple transformer, or from a multiple service, the switch shall be a two-wire, solid neutral, 120 volt AC circuit breaker or fused switch, approved as service equipment, for each sign-pole or panel.

(m) Safety Precautions. Before starting work on existing series street lighting circuits, the contractor shall obtain daily safety circuit clearance from the serving utility. Cut-out plugs must be pulled and "Men at Work" signs posted at cut-out boxes before any work is done.

(n) Inspection. All material shall be subject to inspection after delivery to the site and during installation in the work. Failure of the engineer to note faulty material or workmanship during construction shall not relieve the contractor of the responsibility for removing or replacing any such material at his own expense.

Inspection or sampling of certain materials may be made at the factory or

warehouse prior to delivery to the site, when required by the engineer.

Material which has been rejected previous to delivery shall not be delivered to the work, and all material which has been rejected at the work shall be immediately removed from the site.

(o) Field Test. Prior to completion of the work, the contractor shall cause the following tests to be made on all traffic signal and lighting circuits, in the presence of the engineer.

(1) Test for continuity of each circuit.
(2) Test for grounds in each circuit.
(3) A megger test on each circuit between the circuit and ground. The insulation resistance shall not be less than the values specified in Section 1119 of the code.
(4) A functional test in which it is demonstrated that each and every part of the system functions, as specified or intended herein.
(5) The contractor shall perform, on high voltage series lighting circuits, a high voltage test consisting of an 8,400-volt, 60-cycle alternating current between the conductors and ground for five (5) consecutive minutes with the two ends of the circuit connected together.

The initially applied voltage shall be applied to the entire completed circuit and shall not be greater than the rated voltage of the cable and the rate of increase shall be approximately uniform and not over one hundred (100) percent in ten (10) seconds nor less than one hundred (100) percent in sixty (60) seconds. The voltage shall be increased to the value of 8,400 volts root mean square and held at this value for five (5) minutes.

When approved by the engineer, the contractor may, in lieu of the above 8,400-volt test, perform a high voltage series lighting test consisting of the open circuit voltage of the connected constant current transformer between the conductors and ground.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the contractor in a manner approved by the engineer, and the same test shall be repeated until no fault appears.

(p) Painting. In lieu of the temperature and seasonal restrictions of painting specified in Section 51 of these specifications, paint may be applied to electrical equipment at any time approved by the engineer.

All metal parts, posts, poles, pedestals, standards, sign frames, sign bridges, and fittings shall be cleaned of all rust, scale, grease and dirt as specified in Section 51 prior to applying the priming coat. Sandblasting of galvanized surfaces will not be required.

All base metal and rusted or galvanized surfaces to be painted, shall be treated with a freshly prepared solution of phosporic acid conforming to Federal Specifications MIL-P-15328, Diluent (A). The solution shall be applied by means of a brush. After drying twenty (20) minutes, the metal surfaces shall be rinsed with water. Painting shall begin within twenty-four (24) hours after applying the diluent.

Following the above treatment and prior to installation or erection in the field, all metal posts, poles, pedestals, standards, frames, and fittings to be painted shall receive two primer coats on all inside and outside surfaces. The primer coat shall conform to Section 51 of these specifications. Back plates shall receive a coat of primer.

If an approved prime coat has been applied by the manufacturer and it is in good condition, an application of primer by the contractor, other than for repairs, will not be required.

Where standards are to be finished with yellow enamel, the final prime coat shall be of zinc chromate.

After erection, all exterior surfaces shall be examined for damaged primer and such damaged surfaces shall be given a spot coat of primer.

Metal posts, poles, pedestals, standards and bases below the bottom of signal heads shall be given a minimum of two coats of signal post yellow of a shade approved by the engineer. Final coat shall show even solid color.

Metal parts above the bottom of the base of the signal heads, on poles which are not galvanized or when ordered by the engineer, shall be finished with two coats of dark olive green enamel, except that painting of signal heads which have been factory enameled in black or dark olive green, and are in good condition, may be omitted. Interior of hoods and front faces of back plates shall be finished with two coats of flat black enamel.

Non-galvanized metal lighting standards (without signals), illuminated sign bridges, poles and frames shall be finished with two coats of dark olive green enamel or aluminum as directed by the engineer.

Standards galvanized full length inside and outside in conformance with the current ASTM Designation; A123, will not require painting except that standards used for traffic signals shall be painted yellow as specified above.

Controller cabinets shall be painted dark olive green or aluminum as directed by the engineer. When aluminum paint is specified, the paint shall conform to Section 51 of these specifications.

Conduit and conduit fittings above ground shall be given one coat of primer and one coat of enamel conforming to the color of the adjacent standard or pedestal.

Metal guard posts shall be painted with aluminum or yellow signal post enamel as ordered by the engineer.

Pedestrian push button posts shall be painted with yellow signal post enamel.

All paint coats may be applied either by hand brushing or by approved spraying machines in the hands of skilled operators. The work shall be done in a neat and workmanlike manner, and the department reserves the right to require the use of brushes for the application of paint, should be work done by the paint spraying machine prove unsatisfactory or objectionable, as determined by the engineer.

77.5 Controllers. A controller shall consist of a complete electrical mechanism for controlling the operations of traffic control signals including the timing mechanism and all necessary auxiliary equipment, mounted in a cabinet.

(a) Color phases. Color phases for both traffic-actuated and pretimed traffic signal systems:

(1) For a two-phase controller, the color sequences shall be:

Interval	Phase A	Phase B.
1	Green	Red
2	Yellow	Red
3	Red	Green
4	Red	Yellow

and repeat.

(2) For a three-phase controller, the color sequence shall be:

Interval	Phase A	Phase B	Phase C
1	Green	Red	Red
2	Yellow	Red	Red
3	Red	Green	Red
4	Red	Yellow	Red
5	Red	Red	Green
6	Red	Red	Yellow

and repeat.

(b) Flashing Operations. All controllers shall be equipped for automatic flashing operation of signal lights. Flashing operations, when required by railroad pre-emption, flashing control, or other causes, shall be set for flashing yellow lights, on the main street or highway and for flashing red on the cross street or streets, unless otherwise specified in the special provisions, shown on the plans, or directed by the engineer.

(c) Wiring Diagrams. A schematic wiring diagram of the controllers and auxiliary equipment shall be submitted at the time the controllers are delivered or, if ordered by the engineer, previous to purchase. This diagram shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such manner as to be readily interpreted.

(d) Operating Voltage. All equipment excepting pedestrian push buttons and pressure detectors, shall be designed to operate from 120 volts, 60 cycles AC supply. Operation shall be satisfactory at voltages from 110 to 130.

The voltage for pedestrian push buttons and pressure detectors shall not exceed 12 volts.

(e) Radio Interference Suppressors. All traffic signal controllers, flashers or other current interrupting devices, shall be equipped with suitable radio interference suppressors installed at the input power point. Interference suppressors shall be of a design which will minimize interference in both broadcast and aircraft frequencies, and shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilocycles to 75 megacycles when used in connection with normal installations. The interference filters furnished shall be hermetically sealed in a substantial metal case filled with a suitable insulating compound. Terminals

shall be nickel plated, 10-24 brass studs of sufficient external length to provide space to connect two No. 8 wires, and shall be so mounted that they cannot be turned in the case. Ungrounded terminals shall be properly insulated from each other, and shall maintain a surface leakage distance of not less than one-quarter (1/4) inch, between any exposed current conductor and any other metallic parts, with an insulation factor of 100-200 megohms dependent on external circuit conditions. Suppressors shall be designed for operation on 15 amperes, 125 volts, 60 cycles, single wire circuits, and shall meet standards fo the Underwriters' Laboratories and the Radio Manufacturers Association.

(f) Traffic-Actuated Controllers. Traffic-actuated controllers shall be electrical devices which, when connected to traffic detectors or other means of actuation, or both, shall operate the electrical traffic signal system at one or more intersections.

(1) Type I Controller. Type I controller shall be a two-phase, full traffic-actuated traffic control device which shall be capable of transferring traffic control indication from one phase to the other as the movement of traffic demands. Each phase shall be separately controlled for a predetermined initial interval; a predetermined vehicle interval, which is extended for each actuation; a predetermined maximum interval, which is the limit one phase can hold the right of way while there are actuations on the other phase; a predetermined yellow interval; and a recall switch.

Each phase shall be separately controlled by dials (installed on the front panel of the controller) readily adjustable for the following variables:

(A) Initial interval from 2 to 30 seconds.
(B) Vehicle interval from 2 to 30 seconds.
(C) Maximum interval from 10 to 60 seconds.
(D) Yellow interval from 1 to 10 seconds.

Provision shall be made so that if a vehicle actuates that controller during the green or yellow interval of a phase and does not receive a full vehicle interval, the green shall be recalled to that phase upon completion of the other phase.

(2) Type II Controller. Type II Controller shall be a three-phase, full traffic-actuated traffic control device with similar functions as the Type I controller except that three phases shall be provided.

The controller shall be provided with provisions for skipping any phase when there is no call for that particular phase. When the controller is part of an interconnected system, transfer of the right of way from the coordinated phase shall occur only during the permissive period.

(3) Type III Controller. Type III controller shall be a two-phase, full traffic-actuated traffic control device which shall be capable of transferring traffic control indication from one phase to the other as the movement of traffic demands and shall be capable of increasing and decreasing the various time intervals due to variations in volume of moving traffic and of waiting traffic.

Each phase shall be separately controlled by dials (installed on the front panel of the controller) readily adjustable for the following variables:

(A) Minimum initial interval from 5 to 60 seconds.

(B) Number of cars before minimum initial interval starts to increase from 5 to 50.

(C) Increase of initial interval per car from 0.1 to 2 seconds.

(D) Carry-over effect of traffic during previous green period from 10 to 90 percent.

(E) Passage time for slow-moving vehicles from 5 to 15 seconds.

(F) Maximum period from 10 to 90 seconds.

(G) Change period from 1 to 10 seconds.

(H) Low limit to which vehicle interval can be reduced by waiting time of other phases from 1 to 10 seconds.

(I) Low limit wo which vehicle interval can be reduced by number of other phase waiting cars, from 1 to 10 seconds.

(J) Low limit to which vehicle interval can be reduced by own phase density from 1 to 10 seconds.

(K) Seconds waiting to reduce to low limit from 10 to 90 seconds.

(L) Number of cars waiting to reduce to low limit from 5 to 50, in intervals.

(M) Number of cars per 10 seconds to reduce to low limit from 5 to 50, in intervals.

A recall switch shall be provided for each phase.

Pilot lights shall be provided to indicate the position of the controller at all times with regard to operating intervals on each traffic phase and also to indicate which of the several effects is responsible for termination of right of way.

(4) Type IV Controller. Type IV controller shall be a three-phase full traffic-actuated traffic control device with similar functions as the Type III controller, except that three phases shall be provided and the panel dials shall be readily adjustable for the following variables:

(A) Minimum initial interval from 5 to 60 seconds.

(B) Number of cars before initial interval starts to increase from 5 to 50.

(C) Increase of initial interval per car from 0 to 2 seconds.

(D) Passage time for slow-moving vehicles with recall provision from 5 to 15 seconds.

(E) Low limit to which vehicle interval may be reduced by wait-time of other phase from 1 to 10 seconds.

(F) Seconds of waiting on other phases to reduce vehicle interval to low limit from 10 to 90 seconds.

(G) Maximum period from 10 to 90 seconds.

(H) Change period from 1 to 10 seconds.

The controller shall be provided with a recall switch for each phase and provisions for skipping any phase when there is no call for that particular phase.

Pilot lights shall be provided to indicate the position of the controller at all times with regard to operating intervals on each traffic phase and also to indicate which of the several effects is responsible for termination of right of way.

(5) Type V Controller. Type V controller shall be a two-phase, semi-traffic-actuated control device which shall, in response to calls from the side street, transfer the right of way to the side street. When the controller is part of an interconnected system, transfer of the right of way to the side street shall only be during the permissive periods controlled by a circuit connected to a local synchronization unit or local offset unit.

The controller shall be readily adjustable for the following variables:

(A) Main street minimum green interval from 10 to 90 seconds.
(B) Main street change interval from 2 to 10 seconds.
(C) Side street initial interval from 2 to 12 seconds.
(D) Side street vehicle interval from 2 to 12 seconds.
(E) Side street maximum interval from 10 to 60 seconds.
(F) Side street change interval from 2 to 10 seconds.

(6) Mechanism for Traffic-Actuated Controller. Controllers shall be electrical devices with construction equal to that of first-class electrical instruments. Each variable shall be individually adjustable over its entire range by indicating type knobs, mounted on the timing panel of the controller. Changing the timing of one interval shall not change the timing of any other interval.

The controller shall be so designed that temperature variations between 30 degrees F. and +130 degrees F. shall not change the timing intervals by more than five (5) percent. All similar parts shall be interchangeable.

All contact points which make, break or carry electrical current shall be of fine silver or silver alloy and shall be capable of making, breaking and carrying a current of one hundred-fifty (150) percent of maximum demand load of that particular circuit without causing electrical or mechanical trouble through 1,000,000 operations.

All bearings (except approved sealed bearings) or moving parts shall be of such design that lubrication at one-year intervals shall be sufficient to assure continuous operations.

The complete controller and each auxiliary equipment as specified shall be assembled, wired, and housed in separate dust-proof metal cases. All circuits of each unit shall terminate in a multiple contact connector. Connections between the connector and the terminal block shall be made by means of a flexible cable. Conductors of the cable shall be fitted with terminals to match the terminal block and shall have identifying tags.

In addition to actuation by vehicles, provisions shall be made in the mechanism for each phase, for proposed or potential actuation by means of pedestrian push buttons, or railroad pre-emption, or both, without altering controller mechanism.

(7) Auxiliary Equipment for Traffic-Actuated Controllers. The following auxiliary equipment shall be furnished and installed in each cabinet for traffic-actuated controllers.

(A) Flasher and a switch-operated multi-contact relay which shall cut in flasher and isolate controller from light circuits. Flasher shall be a motor driven, or electronic device, producing between 50 and 60 flashes per minute, and shall provide equal on and off intervals. Flasher mechanism shall be furnished mounted on a plug-in base with plug-in mounting. Multi-contact relay or relays shall have sufficient number of contacts to permit any combination of flashing red or yellow lights and shall be similar in construction to external light relay specified for use with traffic-actuated controller.

(B) External light relays for controllers shall be furnished and installed in controller cabinet, external to the controller.

Relay assembly shall be one of the following types as specified:

Type 1. For two phase controllers - two double pole, contact, double throw relays each mounted on a base for plug-in mounting. For three-phase controllers, six single pole, double contact, double throw relays, mounted as above specified.

Type 2 For each separate phase three single pole, single throw relays, mounted on a base for plug-in mounting.

Relays shall be designed for continuous duty. Relays shall be fitted with silver alloy contacts not less than three-eighths (3/8) inch in diameter, carried on phosphor-bronze arms. Contacts shall be rated at 120 volts, 20 amperes, 60 cycles.

Movable armature shall be of the coil spring return type. Each relay or group of relays shall be furnished mounted on a plug-in base with plug-in mounting. Banana spring type plugs and jacks shall be used for plug-in type mountings (of type commonly used by the department).

(8) Special Auxiliary Equipment. Special auxiliary equipment shall be furnished and installed when shown on the plans or required to perform specified functions, and shall consist of:

(A) Relays to provide overlap shown in phase diagrams. Overlay relays shall be of the same types as specified above for external light relays.

(B) Interval timers for special timing.

(C) Interval timers for pedestrian actuation, which shall be a control device actuated by pedestrian push buttons and capable of controlling any of the full traffic-actuated or semi-traffic-actuated controllers to provide for pedestrian traffic.

Actuation of the pedestrian push buttons shall result in the transfer of right of way in the same sequence as would normally occur in vehicular actuation. The period shall be readily adjustable between the limits of 5 seconds and 30 seconds.

Where flashing indication is required the flasher normally provided with the controller shall be wired into the pre-emption circuit.

(D) A directional detector relay unit for each phase using directional detectors. Quality of construction of unit shall be equal to that required for controllers.

(E) Telephone relay for interconnections.

(9) Controller Housing. Each traffic-actuated controller shall be housed in a weatherproof, anodized cast aluminum cabinet, of sufficient size to contain the controller, all auxiliary equipment, and the following fittings, or as shown on the plans.

(A) Substantial shelves or brackets to support controller and auxiliary equipment.

(B) Control panel assembly consisting of:

1. Plug fuse receptacle.
2. Main power switch.
3. Controller switch. The controller switch shall be wired to energize the controller timing circuits while the signal lights are off or are being operated by flasher.
4. Three-wire, 15 ampere plug receptacle with grounding contact.

(C) Two or more insulated terminal blocks for terminating field wires. Each block shall be provided with 12 poles with pressure type connectors to accomodate not less than five wires size No. 14 AWG.

(D) The cabinet shall have a main door which shall be equipped with a keyed tumbler lock, and an auxiliary door equipped with lock and police key. Door hinge pins shall be made of stainless steel material. Two keys shall be furnished for each lock. the police key shall have a shaft at least one and three-quarter (1-3/4) inches in length.

Cabinet shall be installed with a back toward the nearest line of traffic.

(E) A panel behind the auxiliary door containing the following switches:

1. Main power switch.
2. A switch to control the change from automatic to flashing operations and vice versa. In the "Flashing" position the controller shall be de-energized.

Switch terminals on rear of main cabinet door shall be insulated so that no live parts are exposed.

(F) Screened raintight vents one and one-half (1-1/2) inches in diameter, or larger shall be furnished and installed in the top and the lower back side of the controller cabinet.

A one (1) inch drain hole or pipe, with screen, shall be placed in the foundation, connecting to the cabinet and emptying above the ground line, where cabinet is mounted on concrete pedestal.

(G) All wiring within the cabinet, including connecting cables but excluding wiring within controller timing unit, shall have insulation conforming to the requirements of Article 77.4, sub-article (h-1), of this section, except that connecting cables shall be of stranded copper with two-sixty-fourths (2/64) inch thickness of insulation.

(g) Pre-Timed Controllers. Pre-timed controllers shall be for the purpose of operating pre-timed traffic signal systems and shall be electro-mechanical control devices complete with all accessories and equipment necessary to perform the functions specified.

(1) Types and Functions

(A) Non-Expansible.

Type XXI, non-interconnected controller.
Type XXII, future interconnected controller.
Type XXIII, interconnected controller.
Type XXIV, combined master and intersection interconnected controller

(B) Expansible.

Type XXV, future interconnected controller
Type XXVI, interconnected controller
Type XXVII, combined master and intersection interconnected controller.

(2) Operation. All pre-timed controllers shall be capable of operating as follows:

(A) Manually
(B) As a pre-timed controller of the independent isolated type.
(C) As a synchronous motor-driven coordinated type for progressive timing without interconnecting circuits.

Controllers shall be either one, two, or three dial as specified. Types XXV, XXVI or XXVII controllers shall be the expansible type designed to permit the installation and operation of one to three plug-connected dial units without additional wiring or modification of the controller.

Types XXII and XXV controllers shall be capable of being operated as units in an interconnected, master controlled, flexible progressive system by the addition of easily installed auxiliary attachments.

Types XXIII and XXVI controllers shall be capable of being operated as units in an interconnected, master controlled, flexible progressive system and shall have single electro-mechanical reset per dial unless otherwise specified in the special provisions.

Types XXIV and XXVII controllers shall be similar to Types XXIII and XXVI controllers, except that they shall be equipped with master reset supervision of the intersection controllers.

(3) Mechanism for Pre-Timed Controllers. Mechanism for pre-timed controllers shall be constructed as a complete, self-contained, readily interchangeable unit arranged to swing out for inspection while in operation, All parts shall be readily accessible for maintenance or replacement.

All circuits of each unit shall be terminated in a multiple contact connector. Connection between the connector and the terminal block shall be by means of a flexible cable. Conductors of the cable shall be fitted with terminals to match the terminal block and shall have identifying tags.

(A) Motor and Dial. Controller motor shall be of the self-starting synchronous type, and shall have ample torque for the requirements of the controller operation.

No shaft in motor gear train, except armature spindle, shall be less than one hundred twenty-five thousandths (0.125) inch in diameter.

No gear shall be less than forty-five thousandths (0.45) inch in thickness.

No bearing plate shall be less than six hundred twenty-five ten thousandths (0.0625) inch in thickness.

All intervals in each phase shall be readily adjustable by a suitable dial on the face of the controller in steps of not to exceed one (1) percent of the total cycle by means of self retained timing keys.

(B) Signal Contact Mechanism. All parts of the contact mechanism for signal lights, including contacts and contact supports, shall operate one million (1,000,000) times without mechanical wear that impairs normal operation.

All signal light contact points shall be of fine silver or silver alloy not less than five sixteenths (5/16) inch in diameter, of not less than 10-ampere capacity, capable of operating one million (1,000,000) times without excessive burning or pitting, and shall be easily removed and replaced.

Cam or drum assembly shall provide not less than 12 intervals, all necessary contacts, and provisions for not less than a total of fifteen (15) signal light contacts. Wiring shall be complete to terminal strip from each contact position.

(4) Auxiliary Equipment. All pre-timed controllers shall be equipped with indicating switches and wiring to provide local control of the following functions:

(A) Transfer from automatic to manual operation and vice versa.
(B) Transfer from normal operation to flashing and vice versa.
(C) Transfer from one dial to another (Multidial or expansible controllers only).
(D) Turn off signal lights only (without shutting down timer mechanism).
(E) Shut down timer mechanism.

Combined master and intersection controllers shall have indicating switches for Functions (B) and (C) above for the interconnected system. Switch for local control of Function (C) is not required at the master.

Combined master and intersection controllers shall also have provisions for time switch control of Functions (B) and (C) above for the interconnected system.

Interconnected controllers shall have provisions for remote control of Functions (B) and (C) above.

Non-interconnected controllers shall have provisions for local time switch control of Functions (B) and (C) above.

All pre-timed controllers shall be wired and furnished with plug-in-mounted flasher and jack-mounted relays to permit any combination of flasher red or yellow lights, or both, and shall conform to the provisions of Article 77.5, subarticle f-7-a of this section.

All pre-timed controllers shall be provided with hand switch and cord set for manual operation of signals.

A readily accessible mounting panel shall be furnished in each pre-timed controller cabinet, with adequate provisions for terminating all field circuits and for mounting fuses and relays. Each power and inter-connect circuit (except neutrals) shall be fused.

(5) Special Auxiliary Equipment. The following special equipment shall be furnished and installed when specified in the special provisions or as shown on the plans.

Time switches to control system or local flash, dial change, or other specified functions. Time switch shall be synchronous motor driven equipped with 10-hour spring wound reserve carryover, omitting device and three openings and closings per 24-hour period. Mechanical and electrical characteristics shall be equal to those specified for "Mechanism for Pre-timed Controllers" above.

(6) Housing for Pre-Timed Controllers. The controller shall be enclosed in a weatherproof metal cabinet of the type regularly supplied by the manufacturer, unless otherwise specified. Cabinet shall be fitted with a master-keyed, police lock and shall be mounted on pedestal, as shown on the plans. Two keys, with shanks at least one and three-quarter (1-3/4) inches long, shall be furnished for each controller.

Cabinet shall be fitted with a slip-fitter attachment to permit post-top mounting on a four (4) inch standard pipe pedestal.

Screened raintight vents, one and one-half (1-1/2) inches or larger, shall be furnished and installed on top and the lower backside of the controller cabinet.

77.6 Traffic Signals and Appurtenances. (a) Signal Heads. Each signal head shall be of the adjustable, colored light, vertical type with the number and type of lights detailed herein, and as shown on the plans; shall provide a light indication in one direction only; and shall be adjustable through three hundred and sixty (360) degrees about a vertical axis; and shall be mounted at the location and in the manner shown on the plans. Unless otherwise shown on the plans, all signal heads shall be standard and shall contain three lights arranged; red - top; yellow - center; green - bottom. Pedestrian signals shall be either signal heads arranged: red - top; green - bottom with no wording on lenses, or "Wait-Walk" gas tube type specified hereafter and shall be installed where shown on the plans. All signal heads at any one intersection shall be of the same make and type.

(1) Optical Units. The optical unit shall consist of a lens, a reflector, a lamp holder, and a 67 watt, 130-volt, clear, group replacement, traffic signal lamp, visible to the traffic to be controlled, at all distances from ten (10) to five hundred (500) feet, under all light and traffic conditions except dense fog.

Lenses shall be of the color indicated, circular in shape, with a visible diameter of approximately eight (8) inches, and of such design as to give an outward and downward distribution of light with a minimum above the horizontal. Each lens shall be true to color, of best quality glass, free from imperfections, of high illumination transmission, and shall conform to lastest Specifications of the Institute of Traffic Engineers.

Each reflector shall consist of a one-piece best quality clear glass-parabolical reflector, free from bubbles and striae. The convex surface shall be silvered by chemical deposition to such thickness that the lighted filament of 150-watt incandescent lamp will not be visible through the silver layer. The silvered surface shall be protected by an additional coating of electrolytically deposited copper. An opening in the back of the reflector for the lamp holder shall be so constructed that there will be no dark spots cast on the lens.

The lamp holder shall be of weatherproof moulded construction, immune to the operating temperatures in the unit, of the vibration proof type, and shall be substantially supported independent of the reflector. The lamp holder shall be provided with two wires of sufficient length to be connected to the terminal block specified below.

Each reflector, lens and hood shall be designed in such manner as to reduce sun-phantom to a minimum.

(2) Housing. The signal head housing, or case, shall consist of an assembly of separate sections, expansible type for vertical mounting, substantially secured together in a watertight manner to form a unit of pleasing appearance. Each section shall house an individual optical unit.

Each section shall be complete with a one-piece hinged door, mounting for the lens and other parts of the optical system, watertight gasket, and a simple non-corrodible door-locking device. The optical system shall be so mounted

that the various parts may be swung open for ready access or removal. The section shall be interchangeable and so constructed that sections can be removed or added. There shall be a round opening in the top and bottom of each head to receive one and one-half (1-1/2) inch supporting pipe frame. All parts of the housing, including the doors and end plates, shall be of die cast anodized aluminum conforming to the provisions of the current ASTM Specification: B85, and all parts shall be clean, smooth, and free from flaws, cracks, blow holes, or other imperfections.

All parts such as hinge pins, lens clips, locking devices, etc., shall be made of non-corrodible material.

A terminal block of an approved type shall be mounted inside at the back of the housing. All sockets shall be so wired that a white wire will be connected to the shell of the socket and a black wire to the bottom, or end terminal of the socket. These wires shall in turn be connected to the terminal block mounted in the housing, in the proper manner. The terminal block shall have sufficient studs to terminate all field wires and lamp wires independently, to the block, with separate screws. The terminals to which field wires are attached shall be permanently identified to facilitate field work. Where terminal compartment is used, terminal block in associated heads may be omitted.

Each lens shall be protected with a removable hood of thirty thousandths (0.030) inch thick, sheet anodized aluminum of the full-circle type completely closed, except at the ends, eight (8) inches long (unless otherwise specified) and so designed as to prevent a false indication to traffic not intended to be controlled by that particular signal face. The inside surface of all hoods shall be painted a flat black to prevent reflection.

(b) Directional louvers. Where shown on the plans and in all pedestrian heads (except "Wait-Walk" type), louvers shall be furnished and installed in signal hoods. Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder shall be constructed of No. 22 U.S. gage sheet steel and the vanes shall be constructed of No. 27 U.S. gage sheet steel. Dimensions and arrangements of vanes shall be as shown on the plans.

Louvers shall be galvanized after fabrication by the hot-dipped process in conformance with the current ASTM Designation: A153, and painted with two coats of weather resistant, flat black enamel, as specified in Section 51.

(c) Back plates. Where shown on the plans, back plates shall be furnished and attached to the signal heads. Back plates shall be constructed of anodized, 3-S half-hard, aluminum sheet, fifty-eight thousandths (0.058) inch minimum thickness, and of the dimensions shown on the plans. Back plates shall be painted as specified in Article 77.4, sub-article (p) of this section.

(d) Mounting brackets. Bracket mounted signal heads, as shown on the plans, shall be supported by mounting brackets consisting of assemblies of one and one-half (1-1/2) inch standard steel pipe and malleable iron or brass pipe fittings. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are

concealed within poles and assembly. At each signal location, unless shown otherwise on the plans, a terminal compartment shall be constructed into the mounting brackets, as detailed on the plans. For post-top mounting of bracket-mounted signals the terminal compartment shall be cast with an integral slip-fitter. For post-top mounting of a one-way signal head a slip-fitter without a terminal compartment may be used. Slip-fitter shall fit over a four (4) inch standard pipe. Each slip-fitter shall be provided with two rows of set screws with three screws in each row to secure assembly in plumb position. Set screws shall be cadmium plated. Where signal heads are mounted on electroliers or other tall poles, the terminal compartment shall be designed to bolt or clamp securely to the pole. Each compartment shall be fitted with a terminal block containing twelve (12) poles, each with two pressure type connectors. Each connector shall accommodate at least five No. 14 conductors. A raintight cover shall be provided giving ready access to the terminal block. Terminal compartment shall be of non-frangible metal containing not less than sixty (60) percent copper and shall be of sufficient strength to remain intact in event the pole is knocked down. Slip-fitters where used without integral terminal compartment shall be of cast iron or copper-bearing metal as specified for terminal compartments.

(e) Signal Head Mounting. Signal heads shall be equipeed with positive lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts as shown on the plans.

Signal head assembly for suspension from mast arm shall be equipped with an internally wired plumbing device.

(f) Installing Signal Heads. Signal heads shall not be installed at any intersection until all other signal equipment, including the controller, is in place and ready for operation at that intersection, except that the signal heads may be mounted if the faces are not directed toward traffic or if the faces are covered.

(g) Detectors. Detectors shall be used for actuating traffic-actuated controllers and shall be pressure sensitive type, unless otherwise specified in the special provisions or shown on the plans.

(1) Pressure Sensitive Vehicle Detectors shall be of the non-directional or the directional types or both and of the lengths shown on the plans.

Non-directional detectors, in combination with control equipment, shall be capable of actuation by a vehicle crossing the detector at any speed up to sixty (60) miles per hour under normal conditions.

Directional detectors, in combination with control equipment shall be capable of actuation by a vehicle crossing the detector in one direction at any speed up to thrity-five (35) miles per hour under normal conditions, but not when crossing the detector in the opposite direction.

A directional detector relay unit shall be furnished and installed in the controller cabinet for each phase having a directional detector.

Detectors shall be mounted in a steel frame or housing, having a splicing chamber. The chamber shall be provided with a weather-proof door or cap. Chamber shall be placed in such a position that the chamber door or cap can be opened without disturbing the pavement. All necessary anchoring and installation accessories shall be supplied with each detector. Provision for draining the splice box shall be provided. Pressure type detectors shall be connected by rigid conduit to the nearest junction box.

The detector housings shall be so constructed that contact elements of either the directional or non-directional type can be inserted without disturbing the installation in the pavement. Detector pan shall be prepared as specified in Section 77.4, sub-acticle (c) of this section.

The contact elements of detectors shall be of one-piece construction and shall be so designed that no metal screws or bolts shall be exposed to traffic wear. The surfaces of detector units, which are exposed to traffic, shall consist of rubber, one (1) inch thick. The rubber shall be especially compounded for the duty which it is to perform and shall be securely vulcanized to metal base plate of the contact element. Bolts which hold the contact elements in the housing shall be well graphited before installation and shall not extend above the pavement surface. The rubber surface exposed to traffic shall not be less than eight (8) inches in width and the length shall be approximately the length of the detector. The surface shall not be higher than one-eighth (1/8) inch above the rim of its housing and in no case shall the surface be lower than one-eighth (1/8) inch below the rim.

The electrical contact area of the contact assembly shall be moisture proof and provision shall be provided for making a water-proof splice between the contact area and the conductors.

Detectors shall be so constructed that they will operate on a normally open electric circuit and will make an electrical contact whenever any motor vehicle wheel passes over the detector.

Pavement and base material removed for the installation of the detector housing and foundation shall be disposed of as provided in Article 77.4, sub-article (c) of this section.

(2) Calling detectors shall be pressure sensitive type as described above. Controller circuits shall be wired so that calling circuit shall not operate if advance detector has been actuated.

(h) Pedestrian Push Buttons. Where shown on the plans, pedestrian push buttons of substantial tamper-proof construction shall be furnished and installed. They shall consist of direct push type button and a single momentary contact switch in a cast metal housing on which shall be attached the push button sign shown on the plans. The switch shall have snap action contacts actuated by a three-bladed beryllium copper spring and shall be rated 10 amperes, 125 volts.

The assembly shall be weatherproof and so constructed that it will be impossible to receive any electrical shock under any weather condition. The

housing shall be shaped to fit the curvature of the pole to which it is attached, to provide a rigid installation. Saddles shall be provided to make a neat fit when required.

Push button and sign shall be installed on the cross-walk side of the pole.

(i) Pedestrian Signal Heads. Conventional eight (8) inch signal heads, when used to control pedestrian movement exclusively shall be equipped with louvered hoods.

(j) Pedestrian Signals. Gas tube type pedestrian signals shall conform to the following:

(1) The word "Wait" in red letters shall be immediately above the word "Walk" in green letters with an adequate partition between. The rear half of the red letter tubing shall be blocked out with black blockout paint and the rear half of the green letter tubing shall be blocked out with gray blockout paint. The inside surfaces of the hoods and the surface behind the red "Wait" gas tube shall be finished with two coats of flat black enamel. The surface behind the green "Walk" gas tube shall be finished with two coats of flat white enamel. The exterior surfaces shall be finished with two coats of dark olive green enamel.

(2) The front of the gas tubes section shall be covered with a signal piece of clear plastic.

(3) The housing shall be made of anodized cast aluminum, or equal. A partition shall be installed in the housing so that light from the tubing for one word will not reveal a false indication of the other word. The housing shall be so constructed that it may be used either for post-top mounting or bracket mounting.

(4) Transformers shall be of the proper size for the length of tubing and shall carry the label of Underwriters' Laboratories, Inc., or Electrical Testing Laboratories.

(5) High voltage wiring between the gas tubes and the secondary side of the transformer shall be made with Gas Tube Sign and Oil Burner Ignition Cable, labeled by Underwriters' Laboratories, Inc., for the voltage involved. Conductors shall be No. 14 AWG, or larger, with four-sixty-fourth (4/64) inch insulation.

(6) A double-pole, single-throw disconnect switch shall be mounted within the signal enclosure and connected so as to de-energize the transformer primary circuit.

(7) Relays for operation of the "Wait-Walk" signals shall be placed in the controller cabinet.

77.7 Lighting and Other Systems. (a) Luminaires. Type and style of luminaires, lamp equipment and transformers shall be as specified in the special provisions or as shown on the plans.

All side and end mounted luminaires shall be equipped with one and one quarter (1 1/4) inch slip-fitter.

All side mounted incandescent luminaires shall be equipped with porcelain heat barrier bushing except that for multiple type luminaires glass sleeving may be used.

(b) Flashing Beacons. Where shown on the plans, flashing beacons shall be installed. Beacon shall be a single unit signal head, conforming to the provisions of Article 77.5, sub-article (a) of this section with yellow or red lens as shown on the plans. Mounting of beacon shall be as shown on the plans.

Flasher shall be motor driven or an electronic device without tubes. Contacts shall be silver or silver alloy not less than three-eighths (3/8) inch diameter rated at 20 amperes, 115 volts.

Flasher shall provide 50 to 60 flashes per minute, with equal on and off intervals, and shall be equipped with a radio interference suppressor, as specified for traffic signal controllers.

Workmanship and materials shall be equal to that specified for controllers.

Flasher shall be encased in a raintight housing. When flashing beacons are installed adjacent to or in conjunction with a traffic signal system, the flasher control shall be installed in the controller cabinet unless otherwise shown on the plans.

(c) Sign Lighting Fixtures. Sign lighting fixtures shall be as shown on the plans, or as specified in the special provisions.

(d) Incandescent Sign Lighting Fixtures. Incandescent sign lighting fixtures shall be of the type shown on the plans. Fixtures shall be provided with 120-volt group replacement multiple lamps of wattage rating as shown on the plans.

(e) Photo-Electric Controls. Photo-electric controls as specified in the special provisions or as shown on the plans, shall be one of the following types.

The photo-electric control shall be capable of switching multiple lighting systems directly or of switching series lighting systems through a high voltage controller.

(1) Types. The types of photo-electric controls shall be as follows:

Type I photo-electric control shall consist of a photo-electric unit and a contactor in a single weatherproof housing.

Type II photo-electric control shall consist of a photo-electric unit in a weatherproof housing and a separate contactor located in a traffic signal controller cabinet.

Type III photo-electric control shall consist of a photo-electric unit and a separate contactor, both in weatherproof housings. A switch to permit manual operation of the contactor shall be provided. Switch shall be furnished with an indicating nameplate reading "Auto - Off - Manual" with "Off" in the center position.

(2) Equipment Details.

(A) Photo-Electric Unit. The photo-electric unit shall consist of a light sensitive element connected to control relay, either directly or through a vacuum tube amplifier. The light-sensitive element shall have a spectral response such that it is especially sensitive to north sky illumination and shall have an "on" level adjustable between minimum limits of one (1) and five (5) foot-candles.

The unit shall be so designed that a failure of any electronic component will energize the lighting circuit.

A time delay shall be incorporated into the unit to prevent operation in the event of brief changes in lighting conditions.

The photo-electric unit shall be mounted at the top of the standard designated on the plans and shall be oriented as ordered by the engineer.

(B) Contactor. The contactor shall have contacts rated to switch the specified lighting load and shall be normally open unless otherwise specified.

Contactor shall be either the mechanical armature type (indicated by subscript "-a") or mercury-tube type (indicated by subscript "-m") as specified in the special provisions or shown on the plans.

The mechanical armature type shall consist of an operating coil, a laminated core, a laminated armature, contacts and terminals. Contacts shall be silver alloy.

The mercury-tube type shall consist of an operating coil, necessary mercury tubes and terminals. Mercury tubes shall be hermetically sealed and shall contain an inert gas. Contact shall be made either mercury to mercury or between mercury and contacts of an alloy resistant to both arcing and mercury amalgamation.

(C) Contactor Housing. When located externally, the contactor shall be housed in either a suitable NEMA Type 3 raintight enclosure with dead front panel and hasp for a padlock or in a traffic signal controller cabinet. The raintight enclosure shall be mounted on the same standard as the photo-electric unit at a height of approximately eight (8) feet above the base.

(D) Wiring. Conductors between the photo-electric unit and an

external contactor shall be No. 14 AWG and shall be run inside the lighting standard.

(f) Series-Multiple Transformer. Series-multiple transformer shall conform to the following:

(1) Series-multiple transformer shall operate a 110- to 125- volt multiple load from a single phase, 60 cycle, 6.6 ampers constant current, series circuit.

(2) The secondary voltage shall have a permissible range from 110 volts at full load to 125 volts at one-quarter load and 130 volts at no load without the use of film cutout.

(3) Transformers shall be insulated and NEMA tested for operation of 5,000-volt circuits and shall carry rated volt-amperes continuously without exceeding 55° C. temperature rise above a 40° C. ambient as measured by change in winding resistance.

(4) The case shall be a 16-gage brass pole base type, capable of passing through a nine and one-half (9-1/2) inch by thirteen (13) inch opening. Three brass cable entrance sleeves one and one-half (1-1/2) inches long shall be brazed to the cover. The sleeves are to be suitable for taped joints without threads or wiping sleeve features. The unit shall be watertight and filled with a high melting point insulating compound. The core and coils shall be mechanically attached to the case.

(5) Transformer leads shall be equipped with non-hygroscopic material. There shall be two single-conductor primary leads and one two-conductor secondary lead extending nine (9) inches minimum outside of the sleeves.

(6) Transformer rating shall be as indicated on the plans.

(g) Isolating transformers and Ballasts. Type and style of isolating transformers shall be as specified in the special provisions, or as shown on the plans. Isolating transformers shall be equipped with non-hygroscopic leads and shall be sealed to insure satisfactory operation under continous submersion in water.

Splice at transformers shall conform to the requirements of Article 77.4, subarticle (i) of this section. Where more than one conductor enters a transformer sleeve the insulation and taping shall be applied between the conductors in such a manner as to provide a watertight joint. The splice installation shall be capable of satisfactory operation under continuous submersion in water.

When connecting mercury vapor ballasts to multiple circuits, the primary circuit at each ballast shall be connected to the tap nearest the actual line voltage. The voltage shall be measured when all lamps and other loads on the circuit are energized.

77.8 Salvaging and Reinstalling Electrical Equipment. (a) Salvaging Electrical Equipment. Where shown on the plans or ordered by the engineer,

existing electrical equipment including controllers, cabinets, signal heads, luminaires, standards, pull boxes, and detector frames and pads, etc., shall be removed, cleaned salvaged and stockpiled or reinstalled as specified.

Unless otherwise specified, underground conduit, conductors, bases and detector frames not reused shall become the property of the contractor and shall be removed, except, if not interfering with other construction, said materials may with the written approval of the engineer be abandoned in place.

Care shall be exercised in removing and salvaging electrical equipment so that it will remain in its original form whenever possible. Attention is directed to the provisions of Section 7, Articles 7.7 and 7.9 of these specifications. The contractor will be required to replace, at his own expense, any of the above mentioned electrical equipment which, as determined by the engineer, has been damaged or destroyed by reason of his operations.

(b) Reinstalling Salvaged Electrical Equipment. When salvaged electrical equipment is to be reinstalled, the contractor shall furnish and install all necessary materials and equipment, including anchor bolts, nuts, washers, concrete, etc., required to complete the new installation.

77.9 Guarantee. Upon completion of the work and as condition of final acceptance, the contractor shall furnish a written guarantee to the state in the style of form hereinafter following guaranteeing all of the work, except lamps, installed under this contract for a period of one year, and he shall also furnish a surety bond acceptable to the State in the amount of $1,000, conditioned upon fulfillment of obligations of said guarantee. As a condition of acceptance of the contract, both the guarantee and surety bond, properly executed, shall be filed with the State. Department

STANDARD FORM OF GUARANTEE

Contract No._____

GUARANTEE FOR_____

We hereby guarantee that the_____which we have installed_____at_____ has been done in accordance with the drawings and specifications and that the work as installed will fulfill the requirements of the guarantee included in the specifications. We agree to repair or replace any or all of our work, together with any other adjacent work which may be displaced in so doing that may prove to be defective in its workmanship or material within a period of_____ from date of acceptance of the above named structure by the Department of Highways of the State of Nevada, without any expense whatsoever to the Department ordinary wear and tear and unusual abuse or neglect excepted.

In the event of our failure to comply with the above mentioned conditions within_____days after being notified in writing by the State Highway Engineer, we, collectively or separately

do hereby authorize said Highway Engineer to proceed to have said defects repaired and made good at our expense and we will honor and pay the costs and charges therefor upon demand.

DATED_____ SIGNED_____
(Contractor)

COUNTERSIGNED_____
(Subcontractor)

77.10 Basis of Payment. The lump sum price or prices paid for "Traffic Signal System", "Highway Lighting System" or combination thereof shall be full compensation for furnishing all labor, materials, tools, supplies and equipment and for doing all the work involved in furnishing and installing the electrical equipment or modifying existing equipment, or both, complete in place as shown on the plans and as herein specified including excavation and backfill; concrete foundations, restoring sidewalk, curb, gutter, pavement and appurtenances damaged or destroyed during construction; salvaging existing materials; and making all required tests.

Full compensation for all additional materials and labor, not shown on the plans or called for herein, which are necessary to complete the installations of the electrical systems, shall be considered as included in the prices paid for the systems, and no additional allowance will be made therefor.

SECTION 78

(Blank)

SECTION 79 - FIELD LABORATORY

79.1 Description. This item shall consist of furnishing all materials and erecting a field laboratory for the exclusive use of the engineer, in conformity with these specifications and of the design and dimensions shown on the plans.

79.2 Construction Details. When required herein or by the special provisions, the contractor shall erect a field laboratory. The building shall have a floor plan with the approximate dimensions shown on the plans, shall be located conveniently as directed by the engineer, and shall be independent of any building used by the contractor. It shall be constructed of wood or other approved material and shall be weathertight. The ceiling height shall be not less than eight (8) feet and it shall have windows, doors, tables, lockers, and other equipment as shown on the plans or ordered by the engineer. If the work is prosecuted in cold weather, the contractor shall provide heat for the building.

Upon completion of the work, the building shall become the property of the contractor and he shall remove or otherwise dispose of it to the satisfaction of the engineer.

79.3 Method of Measurement and Basis of Payment. Unless such an item is included in the proposal, this work shall not be paid for directly and compensation for the construction of the laboratory shall be considered as included in the contract prices for other items of the work.

When such an item is included in the proposal, this work shall be paid for at the contract lump sum price for "Field Laboratory," which price shall be full compensation for all labor, materials, tools, supplies, equipment, and incidentals necessary to complete the work.

PART III

MATERIAL DETAILS

SECTION		PAGE
80	WATER	318
81	SELECTED MATERIAL	319
82	AGGREGATE FOR GRAVEL BASE COURSES	320
83	AGGREGATE FOR ROADMIX AND PLANTMIX BITUMINOUS SURFACES	322
84	CRUSHED ROCK AND SCREENINGS FOR ROAD TREATMENT WITH BITUMINOUS MATERIALS	324
85	COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE	327
86	BACKFILL FOR UNDERDRAINS	329
87	STONE FOR MASONRY	330
88	FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE	331
89	SAND BLOTTER	333
90	MORTAR SAND	334
91	LIQUID ASPHALT	335
92	EMULSIFIED ASPHALT	340
93	ASPHALT CEMENT	344
94	ASPHALT JOINT FILLER	347
95	ASPHALT FOR DAMPPROOFING AND WATERPROOFING	348
96	PORTLAND CEMENT	349

SECTION		PAGE
97	STRUCTURAL, RIVET AND EYEBAR STEEL.	350
98	MISCELLANEOUS METALS.	351
99	REINFORCEMENTS.	352
100	HARDWARE.	353
101	CORRUGATED METAL CULVERT PIPE, PIPE ARCHES AND METAL END SECTIONS AND PLATES FOR STRUCTURAL PLATE PIPE, PIPE ARCH AND ARCH.	354
102	CORRUGATED METAL PIPE UNDERDRAINS	356
103	CLAY PIPE	357
104	CONCRETE CULVERT PIPE.	358
105	(BLANK)	
106	PIPE FOR SEWERS, DRAINS AND MISCELLANEOUS PURPOSES. . . .	365
107	TIMBER, , ...	366
108	TIMBER PILES.	368
109	TIMBER PRESERVATIVES.	371
110	FENCE POSTS AND FENCE MATERIALS	372
111	GUARD RAIL MATERIALS.	376
112	EXPANSION JOINT FILLER	378
113	(BLANK)	
114	CURING AGENTS FOR CONCRETE.	379

PART III MATERIAL DETAILS

PART III

MATERIAL DETAILS

SECTION 80 - WATER

80.1 Material Covered. This specification covers the quality of water for use in preparing cement concrete or soil-cement mixtures, and for wetting embankment, backfill, subgrade and gravel base and surfacing courses.

80.2 Requirements. All water for use with cement shall be clean and free from injurious amounts of alkali, acid, oil, organic matter and other deleterious substances and shall be subject to the engineer's approval.

All water for embankments, backfill, subgrade, gravel base and surface courses and cement concrete curing shall be free from an excessive amount of acids, alkali, oil and other substances which, in the opinion of the engineer, will cause damage to the above mentioned items.

Water of doubtful quality for use with cement shall be tested and shall not be used until tested and approved. The water shall cause no indication of unsoundness, marked change in time of setting, or a variation of more than ten (10) per cent in the strength of Standard 1.3 mortar from results obtained with mixtures containing distilled water and the same cement and sand.

Water which is suitable for drinking or ordinary household use may be accepted for use without being tested.

80.3 Samples and Tests. Samples submitted for tests shall each consist of two (2) quarts of water, obtained and shipped in clean glass containers carefully packed and labeled. Tests shall be made in accordance with the current "Standard Method of Test for Quality of Water to be Used in Concrete, AASHO Designation: T26."

SECTION 81 - SELECTED MATERIAL

81.1 Material Covered. This specification covers the quality and size of selected material for base and surfacing.

81.2 General Requirements. Selected material shall consist of pit-run gravel, talus rock, disintegrated granite, other disintegrated rock, cinders, shale or other similar materials.

81.3 Physical Properties. The fraction passing the No. 40 sieve shall have a plasticity index of not more than six (6) and a liquid limit of not more than twenty-five (25). When the material is to be treated with liquid asphalt it shall be of such character that it will pass the stripping and swell tests.

81.4 Size Requirements. The material shall conform to the following sieve analysis:

Laboratory sieve sizes (square openings)	Percentage by weight passing sieve
2 inch	95-100
3/4 inch	85-100
No. 10	40-85
No. 40	15-50
No. 200	*0-25

*The fraction passing the No. 200 sieve shall be less than two-thirds of the fraction passing the No. 40 sieve.

81.5 Sampling and Testing. Sampling and testing of selected material shall be in accordance with the following methods.

Sampling	A.A.S.H.O. T-2
Material Finer than No. 200 Sieve	A.A.S.H.O. T-11
Sieve Analysis	A.A.S.H.O. T-27
Liquid Limit	A.A.S.H.O. T-89
Plasticity Index	A.A.S.H.O. T-91
Swell	Nevada
Stripping Test	Nevada

SECTION 82 - AGGREGATE FOR GRAVEL BASE COURSES

82.1 Material Covered. This specification covers the quality and size of pit-run gravel, screened gravel, crushed gravel, crushed stone, and filler for the following base courses:

(a) Type 1 Gravel Base
(b) Type 2 Gravel Base

82.2 General Requirements. The aggregate shall be the product of approved deposits and shall consist of hard, durable fragments of stone or gravel and a filler of sand or other finely divided mineral matter. It shall be free from an excess of soft or disintegrated pieces, alkali, and vegetable matter.

The minimum amount of crushed material in the finished product shall be as follows:

(a) Type 1 Gravel Base - No requirements.
(b) Type 2 Gravel Base - That obtainable by crushing and incorporating into the finished product all particles in the pit-run material larger than the maximum size specified for the finished product up to and including ten (10) inches in largest dimension.

82.3 Physical Properties. The aggregate shall conform to the following requirements.

	Type 1 Gravel Base	Type 2 Gravel Base
Percentage of wear (L.A. Machine 500 Rev.), % max.	--	45
Fraction passing No. 40 sieve		
Plasticity index, max	6	6
Liquid limit, max	*25	25

*Type 1 Gravel Base having no plasticity index may have a liquid limit as high as 35.

82.4 Size Requirements, Type 1 Gravel Base. The aggregate shall conform to one of the following sieve analyses, the size selection to be optional with the contractor unless otherwise specified:

Laboratory sieve, sizes, (square openings)	Percentage by Weight Passing Sieve		
	Pit run	2-inch size	1-1/2 inbh size
3 inch	- - - -	- - - -	- - - -
2 inch	- - - -	95-100	- - - -
1-1/2 inch	- - - -	- - - -	95-100
1 inch	45-80	50-85	55-95
No. 10	20-45	20-55	25-65
No. 200	0-15	0-18	0-20

Note: If the produce of any deposit is deficient in the fraction passing the No. 10 sieve, additional filler from other approved deposits meeting the physical requirements shall be provided.

82.5 Size Requirements, Type 2 Gravel Base. The aggregate shall conform to one of the following sieve analyses, the size selection optional with the contractor unless otherwise specified:

Laboratory sieve, sizes, (square openings)	Percentage by Weight Passing Sieve	
	1 inch size	3/4 inch size
1 inch	100	---
3/4 inch	80-100	100
No. 4	45-70	50-75
No. 10	30-50	35-55
No. 40	15-35	18-40
No. 200	* 3-12	* 4-12

* The fraction passing the No. 200 sieve shall be less than two-thirds of the fraction passing the No. 40 sieve.

Note: If the product of any deposit is deficient in the fraction passing the No. 10 sieve, additional filler from other approved deposits meeting the physical requirements shall be added at the crushing and screening plant.

82.6 Sampling and Testing. Sampling and testing of aggregate for gravel base courses shall be in accordance with the following standard test methods:

Sampling . . . . . A.A.S.H.O. T-2
Material Finer Than No. 200 Sieve. . . . . A.A.S.H.O. T-11
Sieve Analysis . . . . . A.A.S.H.O. T-27
Liquid Limit . . . . . A.A.S.H.O. T-89
Plasticity Index . . . . . A.A.S.H.O. T-91
Percentage of wear . . . . . A.A.S.H.O. T-96

SECTION 83 - AGGREGATE FOR ROADMIX AND PLANTMIX BITUMINOUS SURFACES

83.1 Material Covered. This specification covers the quality and size of crushed stone or crushed gravel and filler for the following bituminous surface courses:

(a) Roadmix Bituminous Surface.
(b) Plantmix Bituminous Surface.

83.2 General Requirements. The aggregate shall be the produce of approved deposits and shall consist of hard, tough, durable fragments of stone or gravel and a filler of sand or other finely divided mineral matter free from an excess of flat, elongated, soft or disintegrated pieces, alkali, and vegetable matter. The material shall be of such character that it shall pass both the swell and stripping test when mixed with bituminous material.

The amount of crushed material shall be as follows for all classes:

That obtainable by crushing and incorporating into the finished product all particles in the pit-run material larger than the maximum size specified for the finished product up to and including ten (10) inches in largest dimension.

83.3 Physical Properties. The aggregate shall conform to the following requirements:

Percentage of wear (L.A. Machine, 500 revolutions)	
Mx. %	45
Fraction Passing No. 40 sieve	
Plasticity index, max	6
Liquid limit, max	25
Swell test, % max	1.5
Stripping test	Satisfactory

83.4 Size Requirements. The aggregate shall conform to one of the following sieve analyses; the size shall be 3/4 inch unless otherwise specified:

Laboratory Sieve sizes (square openings)	Percentage by weight passing sieve	
	1 inch size	3/4 inch size
1 inch	100	-----
3/4 inch	80-100	100
No. 4	45-70	50-75
No. 10	30-50	35-55
No. 40	15-35	18-40
No. 200	*3-12	*4-12

* The fraction passing the No. 200 sieve shall be less than two-thirds of the fraction passing the No. 40 sieve.

Note: If the product of any deposit is deficient in the fraction passing the No. 10 sieve, additional filler from other approved deposits meeting the physical requirements shall be added at the crushing and screening plant.

83.5 Sampling and Testing. Sampling and testing of aggregate for gravel base courses shall be in accordance with the following methods:

Sampling	A.A.S.H.O. T-2
Material Finer than No. 200 sieve	A.A.S.H.O. T-11
Sieve Analysis	A.A.S.H.O. T-27
Liquid limit	A.A.S.H.O. T-89
Plasticity index	A.A.S.H.O. T-91
Percentage of wear	A.A.S.H.O. T-96
Swell	Nevada
Stripping	Nevada

SECTION 84 - CRUSHED ROCK AND SCREENINGS FOR ROAD TREATMENT WITH BITUMINOUS MATERIALS

84.1 Materials Covered. This specification covers the quality and size of crushed rock and screenings for the following surface courses:

Bituminous Surface Treatment
Bituminous Armor Coat
Retread Surface

84.2 General Requirements. Coarse aggregate and key rock shall be the product obtained by crushing material from approved deposits of ledge rock or gravel. When crushed from gravel, coarse aggregate and key rock shall be the product of crushing particles retained on a screen with square openings not less than one and one-half times the nominal maximum size of the material produced.

Screening may be either stone chips, the product of an approved gravel deposit, or a combination of stone chips and gravel.

All coarse aggregate, key rock, and screenings shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces, alkali and vegetable matter. Material shall be of such character that when mixed with bituminous materials it will pass the stripping test.

84.3 Physical Properties. The aggregate shall conform to the following requirements:

(a) Percentage of wear:
L.A. Machine, 100 rev.,
% max. 8
L.A. Machine, 500 rev.,
% max. 37
Removed by decantation,
% max. 2

(b) Soundness: When subjected to five alternations of the sodium sulphate soundness test the loss shall not be more than ten (10) percent by weight.

84.4 Size Requirements, Bituminous Retread Surface. The aggregate shall conform to one of the following sieve analyses, as specified:

Type 1

Laboratory sieve, sizes, (square openings)	Percentage by Weight Passing Sieve		
	Coarse aggregate	Key Rock	Screenings
2 inch	100	- - - -	- - - -
1-1/2 inch	95-100	- - - -	- - - -
3/4 inch	0-5	100	- - - -
1/2 inch	- - - -	95-100	100
3/8 inch	- - - -	- - - -	90-100
No. 4	- - - -	0-5	- - - -
No. 10	- - - -	- - - -	0-5

Type 2

Laboratory sieve, sizes (square openings)	Percentage by Weight Passing Sieve		
	Coarse aggregate	Key Rock	Screenings
1 inch	100	- - - -	- - - -
3/4 inch	95-100	- - - -	- - - -
3/8 inch	20-55	100	100
1/4 inch	0-10	- - - -	95-100
No. 10	- - - -	0-10	0-5

84.5 Size Requirements, Butiminous Armor Coat. The aggregate shall conform to the following sieve analyses:

Laboratory sieve, sizes, (square openings)	Percentage by Weight Passing Sieve		
	Coarse aggregate	Key Rock	Screenings
1 inch	100	- - - -	- - - -
3/4 inch	95-100	100	- - - -
1/2 inch	0-10	95-100	- - - -
3/8 inch	- - - -	- - - -	100
1/4 inch	- - - -	0-10	95-100
No. 10	0-5	0-5	0-5

84.6 Size Requirements, Screenings for Bituminous Surface Treatment. The aggregate shall conform to the following sieve analyses, as specified:

Laboratory sieve, sizes, (square openings)	Percentage by Weight Passing Sieve	
	1/2 inch size	3/8 inch size
1/2 inch	100	- 100 -
3/8 inch	75-90	90-100
No. 4	8-30	30-60
No. 10	0-8	0-8
No. 200	0-2	0-2

84.7 Sampling and Testing. Sampling and testing of aggregate for coarse aggregate, key rock and screenings shall be in accordance with the following standard test methods:

Sampling	A.A.S.H.O. T-2
Material Finer than No. 200 sieve	A.A.S.H.O. T-11
Sieve Analysis	A.A.S.H.O. T-27
Soundness (Sodium Sulfate)	A.A.S.H.O. T-104
Percentage of wear	A.A.S.H.O. T-96
Stripping	Nevada Section 6

SECTION 85 - COARSE AGGREGATE FOR PORTLAND CEMENT CONCRETE

85.1 Material Covered. This specification covers the quality and size of coarse aggregate for use in concrete pavements or bases, highway bridges and incidental structures.

85.2 General Requirements. Coarse aggregate shall be clean, hard, durable, gravel, crushed gravel, crushed boulders, or crushed stone, free from an excess of thin, elongated pieces, frozen lumps, vegetation or other deleterious matter, and adherent coatings.

The engineer reserves the right to prohibit or forbid the use of aggregates from any source, plant, pit, or deposit, when the character of the material or method of operation is such as to make improbable the furnishing of aggregates conforming to the requirements of these specifications.

85.3 Physical Properties. (a) Deleterious Substances. The amount of deleterious substances shall not exceed the following percentages by weight:

Material passing the No. 200 sieve	1.00
Shale	1.00
Coal and Lignite	1.00
Clay Lumps	0.25
Soft fragements	5.00
Thin or elongated pieces (length greater than five (5) times average thickness)	15.00
Other local deleterious substances, such as alkali, mica, coated grains, soft and flaky particles	2.00
Total of all except thin or elongated pieces	5.00

(b) Percentage of Wear. Coarse aggregate shall conform to the following requirements:

Percentage of wear, Los Angeles Machine, 100 revolutions, % max.	.10
Percentage of wear, Los Angeles Machine, 500 revolutions, % max.	.45

(c) Soundness. When the coarse aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted loss shall be not more than fifteen (15) percent.

85.4 Size Requirements. Coarse aggregate shall be well graded between the limits specified and the size or sizes designated shall conform to the following requirements:

Laboratory Sieve Sizes (square openings)	Percentage by Weight Passing Sieve				
	(1/2 inch to No. 4) Size No. 7	(3/4 inch to No. 4) Size No. 67	(1 inch to No. 4) Size No. 57	(1-1/2 inch to No. 4) Size No. 467	(2 inch to No. 4) Size No. 357
2-1/2 inch	- - -	- - -	- - -	- - -	100
2 inch	- - -	- - -	- - -	100	95-100
1-1/2 inch	- - -	- - -	100	95-100	- - -
1 inch	- - -	100	95-100	- - -	35-70
3/4 inch	100	95-100	- - -	35-70	- - -
1/2 inch	90-100	- - -	25-60	- - -	10-30
3/8 inch	40-70	20-55	- - -	10-30	- - -
No. 4	0-15*	0-10*	0-10*	0-5	0-5

* Not more than five (5) percent shall pass No. 8 sieve.

85.5 Sampling and Testing. Sampling and testing of the coarse aggregate shall be in accordance with the following standard methods of the AASHO with subsequent amendments:

Sampling	T-2
Material passing the No. 200 sieve	T-11
Clay Lumps	T-112
Coal and Lignite	T-113
Percentage of wear	T-96
Sieve Analysis	T-27
Soundness (sodium sulfate)	T-104

SECTION 86 - BACKFILL FOR UNDERDRAINS

86.1 Material Covered. This specification covers the size and quality of filter material for use in backfilling trenches under, around and over underdrain and for pervious blankets.

86.2 General. The material shall consist of clean, coarse sand and gravel or crushed stone conforming to one of the following grading requirements:

Designated Size	Percentage by Weight Passing Laboratory Sieves having Square Openings							
	2-1/2"	1-1/2"	3/4"	No.4	No. 8	No.30	No.50	No.200
Type A	100	80-100	60-95	35-65	25-50	15-25	---	0-3
Type B	---	100	90-100	55-85	35-65	15-35	10-25	0-3
Type C	---	---	100	80-100	60-90	20-50	10-25	0-3

Note: Unless otherwise provided in the special provisions Type B material shall be used.

87.1 [illegible] This specification covers the quality and size of stone for ru[illegible]y, rubble gutters and riprap.

87.2 Quality. Stone used in rubble masonry and riprap shall consist of tough, sound, and durable rock, free from seams, coatings, drys, or other imperfections, and of such character that it will not disintegrate from the action of water.

When tested in accordance with the current "Standard Method of Test for Abrasion of Coarse Aggregates by use of the Los Angeles Machine", A.A.S.H.O. Designation: T-96 the percentage of wear for five hundred (500) revolutions shall not be greater than fifty (50) percent. Stone shall be angular in shape and shall have a rough surface such as will thoroughly bond with the surrounding mortar.

87.3 Size of Masonry Stone. Individual stones shall have a thickness of not less than eight (8) inches and a width of not less than one and one-half times the thickness. No stones except headers shall have a length less than one and one-half times their width. The stones shall decrease in thickness from the bottom to the top of the wall.

87.4 Shaping Masonry Stone. Stones shall be roughly squared on joints, beds and faces. Selected stones roughly squared and pitched to line shall be used at all angles and ends of walls. Shaping or dressing of stones shall be done before the stones are laid in the wall.

87.5 Size of Riprap Stone. Size of riprap stone shall be as large as can be conveniently placed in the layer thickness specified. In layers two (2) feet or less in thickness, the stones, excepting spalls used to chink interstices, shall weigh not less than fifty (50) pounds, and at least sixty (60) percent of them shall weigh more than one hundred (100) pounds each. In layers more than two (2) feet in thickness at least fifty (50) percent of the mass shall be stones having a volume of two (2) cubic feet or more.

87.6 Size of Rubble Stone for Gutters. Stones for rubble gutters shall be not less than six (6) inches nor more than eight (8) inches in thickness with approximately flat top surfaces and with a width of not less than two (2) inches and a length of not less than six (6) inches.

SECTION 88 - FINE AGGREGATE FOR PORTLAND CEMENT CONCRETE

88.1 Material Covered. This specification covers the quality and size of fine aggregate for use in concrete pavements or bases, highway bridges, and incidental structures.

88.2 General Requirements. Fine aggregate shall consist of natural sand or, subject to approval, other inert materials having similar characteristics, or combinations thereof, having hard, strong, durable particles, and shall conform to the requirements of these specifications.

88.3 Physical Properties. (a) Deleterious Substances: The maximum percentage of deleterious substances shall not exceed the following values:

Material passing the No. 200 sieve	3
Coal and lignite	1
Clay Lumps	1
Other local deleterious substances (such as shale, alkali, mica, coated grains, soft and flaky particles)	3

(b) Organic Impurities. All fine aggregate shall be free from injurious amounts of organic impurities. Aggregates subjected to the colorimetric test for organic impurities and producing a color darker than the standard shall be rejected unless they pass the mortar strength test as specified hereinafter.

(c) Soundness. When the fine aggregate is subjected to five (5) alternations of the soldium sulfate test, the weighted percentage of loss shall not be more than ten (10) per cent by weight.

(d) Mortar-Making Properties. Fine aggregates, subjected to the test for mortar-making properties, shall develop a compressive strength at the age of seven (7) and twenty-eight(28) days when using Type I or II cement of not less than ninety-five (95) per cent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 ± 0.10.

88.4 Size Requirements. Fine aggregate shall be well graded from coarse to fine and when tested by means of laboratory sieves shall conform to the following requirements:

Laboratory Sieve Sizes (square openings)	Percentage by weight Passing sieve
3/8 inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10

The above gradation requirements for fine aggregate represent the extreme limits to be used in determining the suitability of material from all possible sources of supply. The gradation from any one source for use on a specific job within these gradation limits shall maintain a uniformity such that variations in the fineness modulus will not exceed ± 0.2 from the fineness modulus of typical representative samples of the material offered for use on the job from State designated sources or by the contractor. Fine aggregate from any one source having a variation in fineness modulus of more than 0.2 either way from the fineness modulus determined from the typical samples shall be rejected, or at the discretion of the engineer may be accepted subject to such changes in the job-mix proportions as he may direct.

Fine aggregates from different sources of supply shall not be mixed or stored in the same pile. They shall not be used alternately in the same class of construction or job-mix without written permission of the engineer. Such permission shall be contingent on amending the job-mix and batch weights as necessary to protect the quality of the concrete produced.

If the fine aggregate for a job-mix is to be a composite material from two or more sources, material from respective sources shall be proportioned separately or blended by methods subject to approval, which will maintain the degree of uniformity or gradation required by these specifications.

88.5 Sampling and Testing. Sampling and testing of fine aggregate shall be in accordance with the following current methods of the A.A.S.H.O.:

Sampling	T-2
Clay Lumps	T-112
Coal and Lignite	T-113
Amount of Material Passing a No. 200 sieve	T-11
Organic Impurities	T-21
Sieve Analysis	T-27
Mortar-Making Properties	T-71
Soundness (Sodium Sulfate)	T-104

SECTION 89 - SAND BLOTTER

89.1 Material Covered. This specification covers the quality and grading of sand for absorbing unpenetrated bituminous material applied as prime coat or seal coat.

89.2 General Requirements. The sand shall be reasonably free from clay, organic matter and other injurious impurities.

89.3 Size Requirements. The sand shall conform to the following sieve analysis:

Laboratory sieve sizes (square openings)	Percentage by weight passing sieve
No. 4	90-100
No. 16	30-75
No. 200	0-12

89.4 Sampling and Testing. Sampling and testing shall be in accordance with the following methods:

Sampling	A.A.S.H.O. T-2
Material Finer than No. 200 sieve	A.A.S.H.O. T-11
Organic Impurities	A.A.S.H.O. T-21
Sieve Analysis	A.A.S.H.O. T-27

SECTION 90 - MORTAR SAND

90.1 Material Covered. This specification covers fine aggregate for use in cement mortar.

90.2 General Requirements. Sand for mortar shall be subject to the same requirements for quality, physical characteristics and properties, deleterious substances, and organic impurities as specified for "Fine Aggregate for Portland Cement Concrete", Section 88 of these specifications.

90.3 Size Requirements. Sand for mortar shall conform to the size requirements for "Fine Aggregate for Portland Cement Concrete", Section 88, except that if the contractor so elects he may screen the sand over a No. 8 screen to produce the following grading:

Laboratory sieve size (square openings)	Percentage by weight passing sieve
No. 8	100
No. 50	15-40
No. 100	0-10
No. 200	0-5

90.4 Sampling and Testing. Sampling and testing of sand for mortar shall be in accordance with the current standard methods of the A.A.S.H.O.:

Sampling	T-2
Organic Impurities	T-21
Mortar-Making Properties	T-71
Sieve Analysis	T-27
Material passing No. 200 sieve	T-11

SECTION 91 - LIQUID ASPHALT

91.1 Material Covered. This specification covers the quality of slow curing, medium curing, and rapid curing liquid asphalts for penetration treatments of road surfaces, roadmix surfaces, plantmix surfaces, and similar uses.

91.2 Test Reports, Shipping Notice and Preliminary Sample. (a) Contractors, vendors, and manufacturers responsibility. At the time of contract award, the contractor shall furnish to the department the name and address of the vendor and/or the manufacturer furnishing the liquid asphalt proposed for use on the project.

If so required by the engineer, the manufacturer shall ship by prepaid express a representative sample of each classification and grade of liquid asphalt proposed for use on the project for testing by the department, and department approval must be obtained prior to ordering shipment.

The vendor of material shall cooperate with representatives of the department in obtaining samples for department testing.

The vendor of the liquid asphalt shall provide a letter of guarantee to the engineer and the contractor stating that each car or truck transport load of material shipped to the project will meet the requirements of these specifications, and that he (the vendor) assumes full responsibility for any diluents or contaminants, remaining as residue from previous loadings of cars or truck tankers which change the quality of the material delivered to the project. Liquid asphalt shipped in cars or truck tankers containing residue from previous loadings in the form of diluents or contaminants will not be paid for at the invoice quantity, but will be rejected or otherwise assessed damages based upon the effects of the dilution or contamination.

(b) Shipping Notice. The division engineer of the division to which shipment is made shall be notified immediately, by wire (teletype or telegraph) upon making shipment and confirming shipping notices shall be mailed immediately thereafter. One copy of the shipping notice shall be mailed to the State Highway Engineer at Carson City, Nevada and two copies shall be mailed to the division engineer of the division to which shipment is made.

The notice by wire shall contain the following data:

1. Consignee and Destination
2. State Contract Number (or State Purchase Order Number, if applicable)
3. Date shipped
4. Net Quantity
5. Car initials and number or truck transport delivery ticket number
6. Type and grade of material

The mailed notice shall contain the following data:

1. Consignee and Destination
2. State Contract Number (or State Purchase Order Number, if applicable)
3. Delivery point
4. Date shipped
5. Car initial and number of truck transport delivery ticket number
6. Type and grade of material
7. Quantity loaded
8. Loading temperature
9. Net quantity
10. Signature of shipper or authorized representative

(c) Refinery Test Reports. Refinery test reports shall be mailed to the State Highway Engineer, Carson City, Nevada as soon as tests have been completed, and the reports shall contain the following data:

1. Date of Shipment
2. Car initials and number of truck transport delivery ticket number
3. Destination and Consignee
4. State Contract Number (or State Purchase Order Number, if applicable)
5. Type and grade of material
6. Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed)
7. Signature of refinery's authorized representative

91.3 Properties and Test Methods. Liquid asphalts of the grade specified shall be homogeneous and shall conform to the requirements set forth in the following tables:

TABLE I

LIQUID ASPHALT, RAPID CURING TYPES

Characteristics	A.A.S.H.O. Test Method	Grades				
		RC-1	RC-2	RC-3	RC-4	RC-5
Flash Point (Tag. open Cup) °F min.	T-79	---	80	80	80	80
Viscosity, Sayboldt-Furol						
At 122° F., Sec		75-150	----	----	----	----
At 140° F., sec	T-72	----	100-200	250-500	----	----
At 180° F., sec		----	----	----	125-250	300-600
Distillation Test						
Distillate (percentage by volume of total distillate to 680° F.)						
to 374° F., min		10	----	----	----	----
to 437°°F., min	T-78	50	40	25	8	----
to 500° F., min		70	65	55	40	25
to 600° F., min		88	87	83	80	70
Residue from distillation to 680° F., Percentage volume by difference, min.	---	60	67	73	78	82
Tests on residue from distillation:						
Penetration at 77° F., 100 g., 5 sec.,	T-49	80-120	80-120	80-120	80-120	80-120
Ductility at 77° F., cm. min	T-51	100	100	100	100	100
Percent soluble in CCl_4, min	*T-44	99.5	99.5	99.5	99.5	99.5

All grades shall be free from water.

* Except that CCl_4 (C.P. grade) shall be used in place of CS_2

TABLE II

LIQUID ASPHALT, MEDIUM CURING TYPES

Characteristics	A.A.S.H.O. Test Methods	Grades				
		MC-1	MC-2	MC-3	MC-4	MC-5
Flash point (Tag. open cup) °F. min	T-79	100	-----	-----	-----	-----
(Cleveland open cup) °F. min	T-48	----	150	150	150	150
Viscosity, Sayboldt-Furol						
at 122° F.		75-~~100~~ 150	-----	-----	-----	-----
at 140° F.	T-72	-----	100-200	250-500	-----	-----
at 180° F.		-----	-----	-----	125-250	300-600
Distillation						
Distillate, percent by volume of total distillate to 680° F.						
to 437° F.		0-20	0-10	0-5	0	0
to 500° F.	T-78	25-65	15-55	5-40	0-30	0-20
to 600° F.		70-90	60-87	55-85	40-80	20-75
Residue from distillation to 680° F., percent of volume by difference, min.		60	67	73	78	82
Tests on residue from distillation:						
Penetration at 77° F., 100 g., 5 sec.	T-49	120-300	120-300	120-300	120-300	120-300
Ductility at 77° F. for residues of less than 200 penetration (cm.)	T-51	100+	100+	100+	100+	100+
Ductility at 60° F. for residue of 200-300 penetration (cm.)	-	100+	100+	100+	100+	100+
Percent soluble in CCl_4, min	*T-44	99.5	99.5	99.5	99.5	99.5

All grades shall be free from water

* Except that CCl_4 (C. P. grade) shall be used in place of CS_2.

TABLE III

LIQUID ASPHALT, SLOW CURING TYPES

Characteristics	A.A.S.H.O. Test Method	Grades					
		SC-1	SC-2	SC-3	SC-4	SC-5	SC-6
Water, % by Volume, max.	T-55	0.5	0.5	0.5	0.5	0.5	0.5
Flash Point (Cleveland O.C.) °F. min.	T-48	150	175	200	225	250	275
Viscosity, Sayboldt-Furol							
at 122° F.	T-72	75-150	-----	-----	-----	-----	-----
at 140° F.		-----	100-200	250-500	-----	-----	-----
at 180° F.		-----	-----	-----	125-250	300-600	-----
at 210° F.		-----	-----	-----	-----	-----	250-500
Distillation							
Total distillate to 680° F., vol. %	T-78	10-30	5-25	2-15	0-10	0.5	0.2
Tests on Residue from Distillation							
Float test at 122° F.	T-50	20-100	25-100	50-125	60-150	75-200	150-350
Percent soluble in CCl_4 min.	*T-44	99.5	99.5	99.5	99.5	99.5	99.5
Asphalt residue of 100 pene. % by weight min.	T-56	50	60	70	75	80	90
Ductility of asphalt residue at 77° F., Min.	**T-51	100	100	100	100	100	100

*Except that CCl_4 (C.P. grade) shall be used in place of CS_2

**The ductility test shall be made on the residue from which the amount of asphalt of 100 penetration is determined. The residue shall be within the penetration range of 85 to 115.

SECTION 92 - EMULSIFIED ASPHALT

92.1 Material Covered. This specification covers the quality of emulsified asphalts. Emulsified asphalt as designated herein shall be composed of an intimate homogeneous mixture of base asphalt and an emulsifying agent held in suspension in water.

92.2 General Requirements. (a) Contractors, vendors, and manufacturers responsibility. At the time of contract award, the contractor shall furnish to the department the name and address of the vendor and/or the manufacturer furnishing the emulsified asphalt proposed for use on the project.

If so required by the engineer, the manufacturer shall ship by prepaid express a representative sample of each classification and grade of emulsified asphalt proposed for use on the project for testing by the department, and department approval must be obtained prior to ordering shipment.

The vendor of material shall cooperate with representatives of the department in obtaining samples for department testing.

The vendor of the emulsified asphalt shall provide a letter of guarantee to the engineer and the contractor stating that each car or truck transport load of material shipped to the project will meet the requirements of these specifications and that he (the vendor) assumes full responsibility for any diluents or contaminants, remaining as residue from previous loadings of cars or truck tankers which change the quality of the material delivered to the project. Emulsified asphalts shipped in cars or truck tankers containing residue from previous loadings in the form of diluents or contaminants will not be paid for at the invoice quantity but will be rejected or otherwise assessed damages based upon the effects of the dilution or contamination.

(b) Shipping Notice. The Division Engineer of the Division to which shipment is made shall be notified immediately, by wire (teletype or telegraph) upon making shipment and conforming shipping notices shall be mailed immediately thereafter. One copy of the shipping notice shall be mailed to the State Highway Engineer, at Carson City, Nevada and two copies shall be mailed to the Division Engineer of the Division to which shipment is made.

The notice by wire shall contain the following data:

1. Consignee and Destination
2. State Contract Number (or State Purchase Order Number, if applicable)
3. Date shipped
4. Net Quantity
5. Car initials and number or truck transport delivery ticket number
6. Type and grade of material

The mailed notice shall contain the following data:

1. Consignee and Destination

2. State contract Number (or State Purchase order Number, if applicable)
3. Delivery point
4. Date shipped
5. Car initial and number or truck transport delivery ticket number
6. Type and grade of material.
7. Quantity loaded
8. Loading temperature
9. Net quantity
10. Signature of shipper or authorized representative.

(c) Refinery Test Reports. Refinery test reports shall be mailed to the State Highway Engineer, Carson City, Nevada as soon as tests have been completed, and the reports shall contain the following data:

1. Date of shipment
2. Car initial and number or truck transport delivery ticket number
3. Destination and consignee
4. State Contract Number (or State Purchase Order Number, if applicable)
5. Type and grade of material
6. Certificate of grade (certify that material conforms to these specifications and itemize results on tests performed)
7. Signature of refinery's authorized representative.

92.3 Specific Requirements. (a) Emulsified Asphalt, Type RS-1. This emulsion is a quick breaking type, intended to be used where a relatively low viscosity and asphalt content is desired. Its principal uses are in penetration work and seal coating, and shall contain an asphalt base of one of the following, as specified.

1. Liquid Asphalt, Type SC-6, conforming to Section ~~94~~ 91, of these Specifications.
2. Asphalt Cement, grade 200-300 or grade 120-150 conforming to Section ~~96~~ 93 of these Specifications.

(b) Emulsified Asphalt, Type RS-2 This emulsion is a quick breaking, high viscosity, relatively high asphalt content type, intended to be used for surface treatment and sealing, and shall contain an asphalt base of one of the following, as specified:

1. Liquid Asphalt, Type SC-6, conforming to Section ~~94~~ 91, of these Specifications.
2. Asphalt Cement, grade 120-150 or grade 85-100 conforming to Section ~~96~~ 93, of these specifications.

(c) Emulsified Asphalt, Type MS-1. This emulsion is a medium breaking, low consistency asphalt intended for use in mixes and shall contain an asphalt base of one of the following, as specified:

1. Liquid Asphalt, Type SC-6, conforming to Section 94, of these Specifications.
2. Asphalt Cement, grade 60-70 or grade 200-300 conforming to Section 96, of these specifications.

Emulsified asphalt shall conform to the requirements of Table I for the type and grade specified when tested in accordance with A.A.S.H.O. as is enumerated.

TABLE I - REQUIREMENTS FOR EMULSIFIED ASPHALT

CHARACTERISTICS	A.A.S.H.O. Test Method	Grades		
		RS-1	RS-2	MS-1
Viscosity, Saybolt-Furol At 77° F., Sec. At 122° F., Sec	T-59	 20-55 	 100-400	 20-55
Residue by distillation at 325° F., % Min.	T-59	55 min.	55 min.	55 min.
Settlement, 5 days, % Maximum.	T-59	3 max.	3 max.	5 max.
* Demulsibility, 50 ml of 0.1N, $CaCl_2$ %				30 max.
* Demulsibility, 35 ml of 0.02N, $CaCl_2$ %		60 min.	45-100	
Sieve Test, % Maximum.	T-59	0.10	0.10	0.10
Modified Miscibility with water, max.	T-59			4-5
Cement Mixing Test, % Maximum.	T-59			2.0
Coating Test	T-59			a

* The demulsibility test shall be made within 30 days after shipment.

a - No appreciable separation in three (3) minutes.

Note: Emulsified Asphalt samples shall be shipped in clean glass or black iron containers.

SECTION 93 - ASPHALT CEMENT

93.1 Material Covered. This specification covers the quality of asphalt cement prepared from petroleum for use in bituminous mixes.

93.2 General Requirements. (a) Contractors, vendors, and manufacturers responsibility. At the time of contract award, the contractor shall furnish to the department the name and address of the vendor and/or the manufacturer furnishing the asphalt cement proposed for use on the project.

If so required by the engineer, the manufacturer shall ship by prepaid express a representative sample of each classification and grade of asphalt cement proposed for use on the project for testing by the department, and department approval must be obtained prior to ordering shipment.

The vendor of material shall cooperate with representatives of the department in obtaining samples for department testing.

The vendor of the asphalt cement shall provide a letter of guarantee to the engineer and the contractor stating that each car or truck transport load of material shipped to the project will meet the requirements of these specifications, and that he (the vendor) assumes full responsibility for any diluents or contaminants, remaining as residue from previous loadings of cars or truck tankers which change the quality of the material delivered to the project. Asphalt cement shipped in cars or truck tankers containing residue from previous loadings in the form of diluents or contaminants will not be paid for at the invoice quantity but will be rejected or otherwise assessed damages based upon the effects of the dilution or contamination.

(b) Shipping Notice. The division engineer of the division to which shipment is made shall be notified immediately, by wire, (teletype or telegraph) upon making shipment and confirming shipping notices shall be mailed immediately thereafter. One copy of the shipping notice shall be mailed to the State Highway Engineer at Carson City, Nevada and two copies shall be mailed to the Division Engineer of the division to which shipment is made.

The notice by wire shall contain the following data:

1. Consignee and Destination
2. State Contract Number (or State Purchase Order Number, if applicable)
3. Date Shipped
4. Net Quantity
5. Car Initials and number or truck transport delivery ticket number
6. Type and grade of material

The mailed notice shall contain the following data:

1. Consignee and Destination
2. State Contract Number (or State Purchase Order Number, if applicable)

3. Delivery Point
4. Date Shipped
5. Car initial and number or truck transport delivery ticket number
6. Type and grade of material
7. Quantity loaded
8. Loading temperature
9. Net quantity
10. Signature of shipper or authorized representative.

(c) Refinery Test Reports. Refinery test reports shall be mailed to the State Highway Engineer, Carson City, Nevada as soon as tests have been completed and the reports shall contain the following data:

1. Date of Shipment
2. Car initial and number or truck transport delivery ticket number
3. Destination and Consignee
4. State Contract Number (or State Purchase Order Number, if applicable)
5. Type and grade of material
6. Certificate of grade (certify that material conforms to these specifications, and itemize results on tests performed)
7. Signature of refinery's authorized representative.

93.3 Specific Requirements. Asphalt cement shall be prepared by the distillation of crude petroleum. This asphalt shall be homogeneous, free from water, and shall not foam when heated to 347° F.

These specificatinns cover the following pentration grades:

60-70
85-100
120-150
200-300

The various penetration grades set forth above shall conform to the requirements and the methods of sampling and testing shall be as shown in Table I.

TABLE I

REQUIREMENTS FOR ASPHALT CEMENT ROAD MATERIALS

CHARACTERISTICS	A.A.S.H.O. Test Method	Penetration Numbers			
		60-70	85-100	120-150	200-300
Penetration, 77° F., 100 g., 5 sec.	T-49	60-70	85-100	120-150	200-300
Flash Point (Cl. op. cup), °F	T-48	450+	450+	425+	350+
Loss on Heating, 325° F., 5 hrs., Max.%	T-47	~~110~~ 1.0	~~110~~ 1.0	~~110~~ 1.0	1.0
Penetration after loss on heating 77°F., 100 g., 5 sec. % of original	T-49	70+	70+	70+	60+
Ductility					
At 77° F., cms.	T-51	100+	100+	60+	---
At 60° F., cms.	T-51	---	---	---	60+
Solubility in Carbon Tetrachloride %	T-44	99.5+	99.5+	99.5+	99.5+
Inorganic Matter (Ash) % max.	T-111	1.0	1.0	1.0	1.0
* Spot Test: (When specified)	T-102				
Standard Naptha Solvent,		Neg.	Neg.	Neg.	Neg.
Naptha Xylene Solvent_____% Xylene		Neg.	Neg.	Neg.	Neg.
Heptane Xylene Solvent, % Xylene		Neg.	Neg.	Neg.	Neg.

Letter from L.W.L. to Mr. Gayle of Phillips Petroleum 2-11-58

* Note: The use of the spot test is optional. When specified, the engineer shall indicate whether standard naptha solvent, the naptha-xylene solvent or the heptane-xylene solvent will be used in determining compliance with the requirements and also, in case of the xylene solvents, the percentage of xylene to be used.

SECTION 94 - ASPHALT JOINT FILLER

94.1 Material Covered. This specification covers the quality of asphalt to be used in filling joints in concrete work.

94.2 General Requirements. Asphalt joint filler for horizontal joints shall conform to the requirements of the current "Standard Specification for Oil Asphalt Filler, AASHO Designation: M18, Grade A".

Filler for use in vertical joints shall be an asphalt conforming to the requirements specified above for horizontal joint filler to which has been added twenty (20) per cent by weight of asbestos filler. Incorporation of the asbestos filler with the asphalt shall be done at the factory of the manufacturer to insure uniform distribution of the filler throughout the mix.

SECTION 95 - ASPHALT FOR DAMPPROOFING AND WATERPROOFING

95.1 Material Covered. This specification covers asphalt suitable for use as a mopping coat in dampproofing, or as a plying or mopping cement in the construction of a membrane system of waterproofing.

95.2 Primer. The material used as a primer shall conform to the current "Specifications For Primer For Use With Asphalt in Dampproofing and Waterproofing" AASHO Designation: M116.

95.3 General Requirements. Mop coat material used above ground shall be "Type A", and that used below ground shall be "Type B".

The asphalt shall be homogeneous and free from water, and shall conform to the requirements prescribed in Table I.

TABLE I - REQUIREMENTS FOR ASPHALT FOR DAMPPROOFING AND WATERPROOFING

	TYPE A		TYPE B	
	minimum	maximum	minimum	maximum
Softening point (ring-and-ball method)	150° F.	170° F.	115° F.	145° F.
Flash point (Cleveland open cut)	400° F.	- - -	350° F.	- - -
Penetration, 77°F., 100 G, 5 Sec.	25	50	50	100
Ductility at 77°F., (5 cm per min.) CM.	5	- - -	30	- - -
Loss on heating at 325°F., 50g, 5HR %	- - -	1	- - -	2
Penetration of residue, percent of original	60	- - -	60	- - -
Total bitumen in carbondisulphide, percent	99	- - -	99	- - -

95.4 Sampling and Testing. The asphalt shall be sampled and tested in accordance with the following standard methods of the American Association of State Highway Officials:

Sampling	T 40
Softening Point	T 53
Flash Point	T 48
Penetration	T 49
Ductility	T 51
Loss on Heating	T 47
Bitumen Soluble in Carbondisulphide	T 44

SECTION 96 - PORTLAND CEMENT

96.1 Material Covered. The cements covered by these specifications are for five (5) types of Portland Cement as required under pertinent sections of these specifications.

96.2 Requirements. The cements shall meet the requirements as set out in the current "Standard Specification for Portland Cement," AASHO Designation M85.

Unless otherwise provided or called for in the Special Provisions, Type II "low-alkali cement" shall be used for all cement concrete and mortar.

96.3 Air-Entraining Agents. Air-Entraining agents used as additives, shall be solutions of materials recognized as acceptable additions to cement for these purposes as they appear in Section 44 "Portland Cement Concrete", However, the engineer reserves the right to check at any time by laboratory tests and other means, the suitability of any of the materials so listed and to verify certification of the manufacturer; and the approval of the listed additives in the Special Provisions or herein shall be considered conditional only and contingent upon actual experience with the use of any specified material listed. Approval may be revoked at any time should it develop that unsatisfactory results of whatever nature are encountered with its use.

The solutions of air-entraining agents shall be added to the ingredients for the concrete in such proportions as to yield entrained air within the range prescribed in Section 44 "Portland Cement Concrete".

SECTION 97 - STRUCTURAL, RIVET, AND EYEBAR STEEL

97.1 General. These specifications cover structural steel for highway structures and other structural purposes. Unless otherwise specified, structural carbon steel and structural rivet steel shall be furnished.

97.2 Mill Test Reports. Two certified copies of the mill test report showing the chemical and physical characteristics of each heat from which metal is used shall be furnished by the contractor.

97.3 Requirements. (a) Structural Carbon Steel. Structural carbon steel shall conform to the requirements of the current "Specification for STEEL FOR BRIDGES AND BUILDINGS," ASTM Designation A7.

(b) Structural Rivet Steel. Structural rivet steel shall conform to the requirements of the current "Specification for STRUCTURAL RIVET STEEL," ASTM Designation A141

(c) Structural Alloy Steel. Structural alloy steel shall conform to the requirements of the current "Specification for LOW-ALLOY STRUCTURAL STEEL," ASTM Designation: A242.

(d) High tensile strength bolts shall conform to the requirements of the current ASTM Designation: A325.

(e) Defects. Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, and other defects. It shall have a smooth, uniform finish, and shall be straightened in the mill before shipment.

Material shall be free from loose mill scale, rust pits, or other defects affecting its strength or durability.

The engineer reserves the right to reject material which he deems unsuitable for the purpose intended even though the material meets the requirements of the mill tolerances.

98.1 Steel Forgings. Steel forgings shall conform to the current requirements of Class C-1 forgings of the current "Specifications for Carbon Steel Forgings for General Industrial Use", ASTM Designation: A235, unless otherwise specified.

98.2 Steel Castings. Steel Castings shall conform to the requirements of the current "Specifications for Mild to Medium Strength Carbon-Steel Castings for General Application", ASTM Designation: A27, Grade 65-35, unless otherwise specified.

98.3 Gray-Iron Castings. Gray-Iron Castings shall conform to the requirements of the current "Standard Specification for Gray-Iron Castings," ASTM Designation: A48, Class 40, unless otherwise specified.

98.4 Malleable Castings. Malleable-Iron Castings shall conform to the requirements of the current "Standard Specification for Malleable-Iron Castings," ASTM Designation: A47, Grade 32510, unless otherwise specified.

98.5 Wrought Iron Plates. Wrought Iron Plates shall conform to the requirements for "Standard Plates", of the current "Standard Specification for Wrought Iron Plates," ASTM Designation: A42.

98.6 Rolled Wrought Iron Shapes and Bars. Rolled Wrought Iron Shapes and Bars shall conform to the current "Standard Specification For the Rolled Wrought Iron Shapes and Bars", ASTM Designation: B207.

98.7 Bronze. Bronze castings shall conform to the requirements for "Alloy B" metal of the current "Standard Specification for Bronze Castings for Bridges and Turntables," ASTM Designation: B22.

98.8 Sheet Lead. Lead shall conform to the requirements of the current "Standard Specification for Pig Lead", ASTM Designation: B29.

The lead shall be of uniform thickness throughout. It shall be free from cracks, seams, slivers, scale, and other surface defects.

98.9 Sheet Copper. Copper shall conform to the requirements of the current "Specifications for Copper Sheet, Strip, and Plate," ASTM Designation: B152. Any type and temper therein described and suitable for the purpose intended may be used. Unless otherwise specified, sheet copper shall have weight of sixteen (16) ounces per square foot.

98.10 Welding Materials. Materials used for welding shall conform to the current "Specifications for Welded Highway and Railway Bridges of the American Welding Society."

SECTION 99 - REINFORCEMENT

99.1 Materials Covered. This specification covers plain and deformed billet steel, fabricated steel bar or rod mats or welded steel wire fabric for concrete reinforcement.

99.2 Bar Steel Reinforcement. (a) Bar steel reinforcement shall meet the requirements of the current "Standard Specification for Billet Steel Reinforcement," AASHO Designation: M31, except that the cold-twisted or hot-twisted bars will not be acceptable. ASTM A15-62T

(b) Unless otherwise provided on the plans or in the special provisions, all bar steel reinforcement shall conform to the requirements of the current "Standard Specification for Minimum Requirements for the Deformations of Deformed Steel Bars for Concrete Reinforcement," AASHO Designation: M137 - ASTM A305-57T

99.3 Fabricated Steel Bar or Rod Mats Reinforcement. Fabricated Steel bar or rod mats for concrete reinforcement shall conform to the requirements of the current "Standard Specification for Fabricated Steel Bar or Rod Mats for Concrete Reinforcement," AASHO Designation: M54.

99.4 Welded Steel Wire Fabric Reinforcement. Welded steel wire fabric shall conform to the requirements of the current "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement", AASHO Designation: M55, ASTM Des. A 185

99.5 Structural Shapes. Structural shapes used as concrete reinforcement shall conform to the requirements for "Structural Steel" as provided in these specifications.

SECTION 100 - HARDWARE

100.1 Material Covered. This specification covers the quality of bolts, nuts, washers, drift pins, dowels, nails, spikes, and other metal fastenings.

100.2 General Requirements. Hardware for use with redwood, Port Orford cedar, or treated timber shall be galvanized. Unless otherwise specified on the plans, hardware for use with other timber need not be galvanized. Galvanizing, when required, shall meet the current "Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware", ASTM Deisgnation: A153.

100.3 Bolts, Nuts, Dowels, and Drift Bolts. Bolts, Nuts, dowels and drift bolts shall conform to the requirements of the current "Specification for Steel Machine Bolts and Nuts and Tap Bolts," ASTM Designation: A307, Grade A, unless otherwise specified.

100.4 Washers. Cast washers shall be of cast iron of the O-gee type. The diameter shall be of not less than three and one-half (3-1/2) times the diamter of the bolts for which it is used and its thickness equal to the diameter of the bolts. The diameter of the hole shall be one-eighth (1/8) inch larger than the diameter of the bolt.

Flat malleable washers shall be of malleable iron with ribs properly propotioned to develop the full strength of the bolt and, unless otherwise shown on the plans, the diameter shall be not less than three and one-half (3-1/2) times the diameter of the bolt for which it is used and its thickness equal to one-half (1/2) the diameter of the bolt. The diameter of the hole shall be one-eighth (1/8) inch larger than the diameter of the bolt.

100.5 Nails and Spikes. Nails shall be cut or round wire of standard form. Spikes shall be cut or wire spikes, or boat spikes, as specified.

SECTION 101 - CORRUGATED METAL CULVERT PIPE, PIPE ARCHES AND METAL END SECTIONS AND PLATES FOR STRUCTURAL PLATE PIPE, PIPE-ARCH AND ARCH

101.1 Material Covered. This specification covers the quality of corrugated galvanized sheet metal pipe, pipe arches, flared metal end-sections and structural plate pipe, pipe-arch and arch intended for use in the construction of galvanized metal plates for culverts and drainage structures.

101.2 Requirement for Corrugated Metal Pipe. Corrugated metal pipe shall conform to the requirements of the current "Standard Specifications for Corrugated Metal Culvert Pipe" AASHO Designation: M36.

101.3 Requirement for Corrugated Metal Pipe Arch Culverts. The requirements for base metal, spelter coating, sampling, riveting, corrugations, and workmanship shall be as prescribed in the current "Standard Specifications for Corrugated Metal Culvert Pipe" AASHO Designation: M36 with the following additions:

(a) Corrugated metal pipe arches shall consist of corrugated metal pipes which have been reformed to be in accordance with the following table:

Span In.	Rise In.	Gage Pipe	Area Sq. Ft.	"T" In.	"R" In.	Gage Bands
18	11	16	1.1	6-1/2	4-1/2	16
22	13	16	1.6	8-1/4	4-3/4	16
25	16	16	2.2	10-3/4	5-1/4	16
29	18	14	2.8	12-1/2	5-1/2	16
36	22	14	4.4	15-3/4	6-1/4	16
43	27	12	6.4	20	7	14
50	31	12	8.7	23	8	14
58	36	12	11.4	26-3/4	9-1/4	14
65	40	12	14.3	29-1/2	10-1/2	14
72	44	10	17.6	32-1/4	11-3/4	12

All dimensions are measured from the inside crests of the corrugations. A tolerance of plus or minus one (1) inch will be permissible in span, rise, "T" and "R". The dimensions "T" and "R" shall be measured vertically from a horizontal line drawn across the widest portion of the arch. The dimension "T" is the distance from this horizontal line to the highest point of the intrados of the arch. The dimension "R" is the distance from this horizontal line to the lowest portion of the base. The minimum radius of the curvature of any part of the pipe arch section shall be four (4) inches.

The lapped longitudinal seams shall be factory riveted and shall be staggered so as to alternate on each side of the center of the top of the arch by approximately fifteen (15) percent of the periphery.

101.4 Requirements for Flared Metal End-Sections. This specification covers metal end sections to be attached to the inlet and/or outlet ends of corrugated metal pipe or pipe arch culverts.

(a) Material. The materials used to fabricate flared metal end sections shall meet the requirements of the AASHO Specification: M36 for base metal, rivets, and riveting.

(b) Fabrication. The flared metal end sections fabricated under this specification shall be made to conform to the shape and dimensions and number of pieces as shown on the standard drawing.

101.5 Protective Coatings. (a) Coated Only. When required by the Special Provisions or when shown on the plans, the corrugated metal pipe culverts and/or corrugated metal pipe arch culverts shall be bituminous coated in accordance with the provisions of AREA, C&M Section-Engineering Division-AAR, Chapter 1, Part 4, Specifications for Bitminous Coated Metal Pipe and Arches.

(b) Paved Invert Corrugated Metal Culverts. When required by the Special Provisions or when shown on the plans the corrugated metal pipe culverts paved and/or corrugated metal pipe arch culverts shall be bituminous coated and paved in accordance with the provisions of AREA, C&M Section-Engineering Division-AAR, Chapter 1, Part 4, Specifications for Bituminous Coated Metal Pipe and Arches.

101.6 Requirements for Asbestos Bonded Corrugated Metal Pipe and Pipe Arches. Asbestos bonded corrugated metal pipe and pipe arch shall conform to the standard specifications of AASHO Designation: M36 for base metal and fabrication where applicable. The pipe shall be formed from sheets which have been coated with a layer of asbestos fibers, applied in a sheet form by pressing them into the molten metallic bonding medium. The pipe or pipe arch shall be coated in accordance with Specification 101.5(a) and when required by the Special Provisions or shown on the plans, coated and paved in accordance with Specification 101.5(b).

101.7 Requirements for Structural Plate Pipe, Pipe-Arch and Arch. Structural plate pipe, pipe arch, and arch shall conform to the requirements of the current specifications for structural plate, pipe, pipe arch, and arch as set forth in Sections 10 and 11, Division III of the "Standard Specification for Highway Bridges" of the AASHO. The gage of the plates shall be as required on the plans or in the special provisions.

SECTION 102 - CORRUGATED METAL PIPE UNDERDRAINS

102.1 Material Covered. This specification covers the quality of perforated corrugated galvanized sheet metal pipe intended for use in the construction of underdrains.

102.2 Requirements. Perforated corrugated galvanized sheet metal pipe for underdrains shall conform to the requirements of the current "Standard Specification for Corrugated Metal Pipe Underdrains", AASHO Designation: M136.

SECTION 103 - CLAY PIPE

103.1 Material Covered. This specification covers two classes of clay pipe as follows:

Standard-Strength Clay Pipe intended to be used for conveyance of sewage, industrial wastes and storm water.

Extra-Strength Clay Pipe intended to be used for the construction of culverts under the roadway.

103.2 Requirements. Clay pipe shall conform to the requirements for the particular classes of the current "Standard Specifications for Clay Pipe", AASHO Designation: M65.

SECTION 104 - CONCRETE CULVERT PIPE

104.1 Scope. This specification covers concrete pipe intended to bee used under the highway roadbed for the construction of culverts, siphons, pressure conduits, sewers and storm drains.

Except where otherwise indicated in these specifications, the pipe shall conform to the current AASHO Designation: M41.

104.2 General. (a) Materials. The concrete of which these pipes are made shall be composed of a uniform blended mixture of Portland cement, water, fine aggregates and coarse aggregate, each of which shall conform to the specifications as given in Part III under their respective titles. At the descretion of the manufacturer, the grading requirements for fine aggregate or coarse aggregate, or both may be waived but this shall not relieve the manufacturer of the responsibility for meeting all the other requirements of these specifications.

(b) Manufacture. The pipe may be manufactured by any of the following approved methods: Vibro-cast, tamped, "Packerhead" or centrifugal, provided the finished product will meet the requirements as herein specified.

(d) Testing. Pipe shall be tested for strength by the three (3) edge bearing method. For pipe, of larger diameters, where standard testing equipment is not readily available, acceptability may be determined by tests of the quality of the concrete, and an examination of the quality, accuracy of placement, and amount of the reinforcement. The concrete, when molded into six (6) inch by twelve (12) inch cylinders, cured under identical conditions with the pipe in which it is used and tested in accordance with AASHO Method T22, shall have a compressive strength, at the time the pipe are accepted for shipment, of not less than that set forth in the Tables.

The absorption shall not exceed seven (7) per cent of the dry weight for machine made, nor eight (8) per cent for cast pipe. The absorption shall be determined on samples taken approximately from the center of the length of the pipe.

(d) Marking. All pipe shall be plainly marked with the name or trademark of the manufacturer and the date made. The table number identifying the pipe shall be clearly marked on each length.

104.3 Detail Requirements. Concrete culvert pipe shall be furnished in six class grades, as required in accordance with the design given in Tables I, II, III, IV, V and VI. Unless otherwise specified, Class III pipe shall be supplied.

TABLE I

DESIGN REQUIREMENTS FOR REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE[a]

CLASS I

The strength test requirements in lbs. per lin. ft. of pipe under the 3-edge-bearing method of testing shall be either the D-Load to produce a 0.01-inch crack, or the D-Loads to produce the 0.01-inch crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in feet.

D-Load to produce an 0.01-inch crack: 800

D-Load to produce the ULTIMATE load: 1200

Test loads for sand bearing tests shall be one and one half times those specified above for the 3-edge-bearing test.

The mimimum compressive strength of the concrete at the time of acceptance shall be as tabulated below.

Int. Dia. of Pipe, Ins.	Minimum Reinforcement in Sq. In. per lineal foot of pipe barrel							
	WALL "A" Concrete Strength: 4000 psi				WALL "B" Concrete Strength: 4000 psi			
	Min. Wall Thick., Ins.	Circular Reinf. in Circ. Pipe: Inner Cage	Circular Reinf. in Circ. Pipe: Outer Cage	Elliptical Reinf. in Circ. Pipe & Circ. Reinf. in Elliptical Pipe	Min. Wall Thick, Ins.	Circular Reinf. in Circ. Pipe: Inner Cage	Circular Reinf. in Circ. Pipe: Outer Cage	Elliptical Reinf. in Circ. Pipe and Circ. Reinf. in Elliptical Pipe
60	5	.25	.19	.28	6	.21	.17	.23
66	5-1/2	.30	.22	.33	6-1/2	.25	.19	.28
72	6	.35	.26	.39	7	.29	.22	.32
78	6-1/2	.41	.30	.44	7-1/2	.32	.24	.36
84	7	.45	.34	.51	8	.37	.28	.41
90	7-1/2	.49	.37	.54	8-1/2	.41	.32	.46
96	8	.54	.41	.61	9	.46	.35	.51
	Concrete Strength: 5000 psi							
102	8-1/2	.63	.48	Inner Circular .22 / Plus Elliptical .48	9-1/2	.54	.41	Inner Circular .20 / Plus Elliptical .41
108	9	.68	.51	Inner Circular .25 / Plus Elliptical .51	10	.61	.46	Inner Circular .22 / Plus Elliptical .46

(a) For sizes and loads beyond those shown in the above tables, pipe may be supplied using special designs involving one or more of the following: wall thickness, high strength concrete, shear reinforcement.

(b) Steel areas may be interpolated between those shown for variations in diameter, loading or wall thickness. Pipe over 96 " must have two circular cages or an inner circular plus one elliptical cage of the minimum steel areas shown.

(c) The elliptical steel in circular pipe or the circular steel in elliptical pipe must be held in place by means of holding rods or chairs or other positive means throughout the entire length of the pipe and throughout the entire casting operation and remain in place until the concrete has taken its initial set.

TABLE II

DESIGN REQUIREMENTS FOR REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE[a]

CLASS II

The strength test requirements in lbs. per lin. ft. of pipe under the 3-edge-bearing method of testing shall be either the D-Load to produce a 0.01-inch crack, or the D-Loads to produce the 0.01-inch crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in feet.

D-Load to produce an 0.01-inch crack: 1000

D-Load to produce the ULTIMATE load: 1500

Test loads for sand bearing tests shall be one and one half times those specified above for the 3-edge-bearing test.

The mimimum compressive strength of the concrete at the time of acceptance shall be as tabulated below.

Int. Dia. of Pipe, Ins.	Minimum Reinforcement in Sq. In. per lineal foot of pipe barrel							
	WALL "A" Concrete Strength: 4000 psi				WALL "B" Concrete Strength: 4000 psi			
	Min. Wall Thick., Ins.	Circular Reinf. in Circ. Pipe		Elliptical Rein in Circ. Pipe & Circ. Reinf in Elliptical Pipe	Min. Wall Thick, Ins.	Circular Reinf. in Circ. Pipe		Elliptical Reinf. in Circ. Pipe and Circ. Reinf. in Elliptical Pipe
		Inner Cage	Outer Cage			Inner Cage	Outer Cage	
12	1-3/4	.07	--	--	2	.07	--	--
15	1-7/8	.07	--	--	2-1/4	.07	--	--
18	2	.10	--	.07	2-1/2	.07	--	.07
21	2-1/4	.12	--	.10	2-3/4	.10	--	.09
24	2-1/2	.13	--	.11	3	.11	--	.10
27	2-5/8	.15	--	.13	3-1/4	.13	--	.11
30	2-3/4	.15	--	.14	3-1/2	.14	--	.12
33	2-7/8	.17	--	.15	3-3/4	.15	--	.13
36	3	.14	.10	.15	4	.12	.09	.13
42	3-1/2	.17	.12	.18	4-1/2	.15	.12	.17
48	4	.21	.17	.23	5	.18	.14	.20
54	4-1/2	.25	.19	.28	5-1/2	.22	.17	.24
60	5	.30	.22	.33	6	.25	.19	.28
66	5-1/2	.35	.26	.39	6-1/2	.31	.23	.34
72	6	.41	.30	.45	7	.35	.26	.40
78	6-1/2	.46	.35	.51	7-1/2	.41	.30	.44
84	7	.51	.39	.57	8	.46	.34	.51
90	7-1/2	.57	.44	.63	8-1/2	.51	.38	.57
96	8	.62	.48	.69	9	.57	.43	.63
	Concrete Strength: 5000 psi				Concrete Strength: 5000 psi			
102	8-1/2	.76	.57	Inn. Circ. + Ell. / .57	9-1/2	.68	.51	Inn. Circ. + Ellip. / .51
108	9	.85	.64	Inn. Circ + Ellip. / .64	10	.76	.57	Inn. Circ. + Ellip. / .57

(a) For sizes and loads beyond those shown in the above tables, pipe may be supplied using special designs involving one or more of the following: wall thickness, high strength concrete, shear reinforcement.

(b) Steel areas may be interpolated between those shown for variations in diameter, loading or wall thickness. Pipe over 96" in diameter must have two circular cages or an inner circular plus one elliptical cage of the minimum steel areas shown.

(c) Elliptical steel in circular pipe over 60 " in diameter or circular steel in elliptical pipe over 60 " in diameter must be held in place by means of holding rods or chairs or other positive means throughout the entire length of the pipe and throughout the entire casting operation and remain in place until the concrete has taken its initial set.

TABLE III

DESIGN REQUIREMENTS FOR REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE[a]

CLASS III

The strength test requirements in lbs. per lin. ft. of pipe under the 3-edge-bearing method of testing shall be either the D-Load to produce a 0.01-inch crack, or the D-Loads to produce the 0.01-inch crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in feet.

D-Load to produce an 0.01-inch crack: 1350

D-Load to produce the ULTIMATE load: 2000

Test loads for sand bearing tests shall be one and one half times those specified above for the 3-edge-bearing test.

The mimimum compressive strength of the concrete at the time of acceptance shall be as tabulated below.

Int. Dia. of Pipe, Ins.	Minimum Reinforcement in Sq. In. per lineal foot of pipe barrel											
	WALL "A" Concrete Strength: 4000 psi				WALL "B" Concrete Strength: 4000 psi				WALL "C" Concrete Strength: 4000 psi			
	Min. Wall Thick., Ins.	Circular Reinf. in Circular Pipe		Elliptical Reinf in Circ. Pipe & Circ. Reinf. in Elliptical Pipe	Min. Wall Thick, Ins.	Circular Reinf. in Circ. Pipe		Elliptical Reinf. in Circ. Pipe and Circ. Reinf. in Elliptical Pipe	Min. Wall Thick., Ins	Circular Reinf. in Circ. Pipe		Elliptical Reinf in Circ. Pipe & Circ. Reinf. in Elliptical Pipe
		Inner Cage	Outer Cage			Inner Cage	Outer Cage			Inner Cage	Outer Cage	
12	1-3/4	.08	--	--	2	.07	--	--				
15	1-7/8	.09	--	--	2-1/4	.08	--	--				
18	2	.11	--	.09	2-1/2	.09	--	.07				
21	2-1/4	.14	--	.11	2-3/4	.12	--	.09				
24	2-1/2	.17	--	.14	3	.14	--	.12				
27	2-5/8	.18	--	.17	3-1/4	.17	--	.14				
30	2-3/4	.19	--	.18	3-1/2	.18	--	.15				
33	2-7/8	.21	--	.20	3-3/4	.15	.11	.17				
36	3	.21	.17	.23	4	.17	.13	.19				
42	3-1/2	.25	.19	.28	4-1/2	.21	.17	.23				
48	4	.32	.24	.35	5	.24	.18	.28				
54	4-1/2	.38	.28	.42	5-1/2	.29	.22	.32				
60	5	.44	.33	.49	6	.34	.26	.38				
66	5-1/2	.51	.37	.56	6-1/2	.41	.32	.46				
72	6	.57	.44	.63	7	.49	.37	.54	7-3/4	.37	.28	.41
	Concrete Strength: 5000 psi											
78	6-1/2	.64	.48	.71	7-1/2	.57	.44	.63	8-1/4	.42	.32	.48
84	7	.73	.54	.80	8	.64	.48	.71	8-3/4	.51	.38	.56
90	7-1/2	.81	.61	.90	Concrete Strength: 5000 psi							
					8-1/2	.69	.52	.78	9-1/4	.59	.45	.66
96	8	.93	.70	1.03	9	.76	.57	.84				
102	8-1/2	1.03	.78	Inn. Cir. + Ellip. .37 / .78	9-1/2	.90	.68	Inn. Circ. + Ellip. .32 / .68				
108	9	1.22	.91	Inn. Cir. + Ellip. .45 / .91	10	1.08	.81	Inn. Circ. + Ellip. .39 / .81				

(a) For sizes and loads beyond those shown in the above tables, pipe may be supplied using special designs involving one or more of the following: wall thickness, high strength concrete, shear reinforcement.

(b) Steel areas may be interpolated between those shown for variations in diameter, loading or wall thickness. Pipe over 96-in. in diameter must have two circular cages or an inner circular plus one elliptical cage of the minimum steel areas shown.

(c) The elliptical steel in circular pipe over 60" in diameter or the circular steel in elliptical pipe over 60" in diameter must be held in place by means of holding rods or chairs or other positive means throughout the entire length of the pipe and throughout the entire casting operation and remain in place until the concrete has taken its initial set.

TABLE IV

DESIGN REQUIREMENTS FOR REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE[a]

CLASS IV

The strength test requirements in lbs. per lin. ft. of pipe under the 3-edge-bearing method of testing shall be either the D-Load to produce a 0.01-inch crack, or the D-Loads to produce the 0.01-inch crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in feet.

D-Load to produce an 0.01-inch crack: 2000

D-Load to produce the ULTIMATE load: 3000

Test loads for sand bearing tests shall be one and one half times those specified above for the 3-edge-bearing test.

The mimimum compressive strength of the concrete at the time of acceptance shall be as tabulated below.

Int. Dia. of Pipe Ins.	Minimum Reinforcement in Sq. In per lineal foot of pipe barrel											
	WALL "A" Concrete Strength: 5000 psi				WALL "B" Concrete Strength: 4000 psi				WALL "C" Concrete Strength: 4000 psi			
	Min. Wall Thick., Ins.	Circ. Reinf. in Circ. Pipe		Elliptical Reinf. in Circ. Pipe & Circ. Reinf. in Elliptical Pipe	Min. Wall Thick, Ins.	Circular Reinf. in Circ. Pipe		Elliptical Reinf. in Circ. Pipe and Circ. Reinf. in Elliptical Pipe	Min. Wall Thick. Ins.	Circular Reinf. in Circ. Pipe		Elliptical Reinf. in Circ. Pipe & Circ. Reinf. in Elliptical Pipe
		Inner Cage	Outer Cage			Inner Cage	Outer Cage			Inner Cage	Outer Cage	
12	1-3/4	.15	--	--	2	.09	--	--				
15	1-7/8	.17	--	--	2-1/4	.12	--	--				
18	2	.17	--	.15	2-1/2	.15	--	.12				
21	2-1/4	.23	--	.21	2-3/4	.20	--	.17				
24	2-1/2	.29	--	.28	3	.28	--	.23	4	.07	.07	.08
27	2-5/8	.33	--	.32	3-1/4	.32	--	.25	4-1/8	.08	.07	.09
30	2-3/4	.38	--	.35	3-1/2	.35	--	.28	4-1/4	.09	.07	.10
33	- - - - - - - - - - - -				3-3/4	.28	.20	.30	4-1/2	.11	.08	.12
36	- - - - - - - - - - - -				4	.30	.22	.33	4-7/8	.14	.10	.15
42	- - - - - - - - - - - -				4-1/2	.35	.26	.39	5-1/4	.20	.15	.22
48	- - - - - - - - - - - -				5	.42	.32	.48	5-3/4	.26	.20	.29
54	- - - - - - - - - - - -				5-1/2	.51	.37	.56	6-1/8	.34	.26	.38
60	- - - - - - - - - - - -				Concrete Strength: 5000 psi							
					6	.59	.45	.66	6-3/4	.41	.32	.46
66	- - - - - - - - - - - -				6-1/2	.69	.52	.78	7-1/4	.51	.39	.57
72	- - - - - - - - - - - -				7	.79	.61	.88	Concrete Strength: 5000 psi			
									7-3/4	.61	.46	.68
78	- - - - - - - - - - - -				- - -	- - -	- - -	- - - - -	8-1/4	.71	.53	.79
84									8-3/4	.85	.63	.94

(a) For sizes and loads beyond those shown in the above tables, pipe may be supplied using special designs involving one or more of the following: wall thickness, high strength concrete, shear reinforcement.

(b) Steel areas may be interpolated between those shown for variations in diameter, loading or wall thickness.

(c) The elliptical steel in circular pipe over 42 inches in diameter or the circular steel in elliptical pipe over 42inches in diameter must be held in place by means of holding rods or chairs or other positive means throughout the entire length of the pipe and throughout the entire casting operation and remain in place until the concrete has taken its initial set.

TABLE V

DESIGN REQUIREMENTS FOR REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE[a]

CLASS V

The strength test requirements in lbs. per lin. ft. of pipe under the 3-edge-bearing method of testing shall be either the D-Load to produce a 0.01-inch crack, or the D-Loads to produce the 0.01-inch crack and the ultimate load as specified below, multiplied by the internal diameter of the pipe in feet.

D-Load to produce an 0.01-inch crack: 3000

D-Load to produce the ULTIMATE load: 3750

Test loads for sand bearing tests shall be one and one half times those specified above for the 3-edge-bearing test.

The mimimum compressive strength of the concrete at the time of acceptance shall be as tabulated below.

Int. Dia. of Pipe, Ins.	Minimum Reinforcement in Sq. In. per lineal foot of pipe barrel							
	WALL "B" Concrete Strength: 6000 psi				WALL "C" Concrete Strength: 6000 psi			
	Min. Wall Thick., Ins.	Circular Reinf. in Circ. Pipe		Elliptical Reinf. in Circ. Pipe and Circ. Reinf. in Elliptical Pipe	Min. Wall Thick., Ins.	Circular Reinf. In Circ. Pipe		Elliptical Reinf. in Circ. Pipe & Circ. Reinf. in Elliptical Pipe
		Inner Cage	Outer Cage			Inner Cage	Outer Cage	
12	2	.11	--	--				
15	2-1/4	.18	--	--				
18	2-1/2	.26	--	.22				
21	2-3/4	.34	--	.30				
24	3	.48	--	.39	4	.12	.09	.13
27	3-1/4	.38	.28	.42	4-1/8	.14	.11	.17
30	3-1/2	.41	.32	.46	4-1/4	.18	.14	.20
33	3-3/4	.46	.35	.51	4-1/2	.23	.17	.25
36	4	.51	.38	.56	4-7/8	.28	.20	.30
42	4-1/2	.61	.45	.67	5-1/4	.37	.28	.41
48	5	.73	.56	.81	5-3/4	.48	.35	.52
54					6-1/8	.58	.44	.64
60					6-3/4	.70	.53	.78
66					7-1/4	.84	.63	.93
72					7-3/4	.99	.75	1.10

(a) For sizes and loads beyond those shown in the above tables, pipe may be supplied using special designs involving one or more of the following: wall thickness, high strength concrete, shear reinforcement.

(b) Steel areas may be interpolated between those shown for variations in diameter, loading or wall thickness.

(c) Elliptical steel in circular pipe or circular steel in elliptical pipe must be held in place by means of holding rods or chairs or other positive means throughout the entire length of the pipe and throughout the entire casting operation and remain in place until the concrete has taken its initial set.

104.4 Centrifugally Cast Concrete Pipe. The use of Centrifugally Cast Concrete Pipe will be permitted except for the extension of existing culvert lines of different detail design. The pipe shall conform to all of the requirements specified herein, with the following modifications:

(a) Reinforced Concrete Pipe manufactured by the centrifugal method shall be formed and compacted in a horizontal position by centrifugal force developed with a suitably designed machine. The machine shall be of sufficient rigidity so that the forms may be revolved without harmful vibration at speeds sufficient to insure even distribution and dense packing of the concrete.

Filling of the forms shall be accomplished while the forms are revolved at a speed that will insure uniform distribution of concrete throughout the wall of the pipe.

After the concrete has been densely packed, all water, laitance and any float material shall be removed from the inner surface of the pipe, and it shall then be smoothed preparatory to the second and final spin.

(b) The minimum wall thickness of the pipe shall be as specified in Tables I, II, III, IV or V for the class of pipe being manufactured.

(c) The quality of the concrete shall be determined from 6" x 12" test cylinders made from the concrete used in making the pipe, spun and cured under identical conditions with the pipe, or by three edge bearing method.

104.5 Heavy Wall - Non-Reinforced Concrete Culvert Pipe. Heavy-wall non-reinforced concrete pipe shall conform to the following minimum wall thicknesses and shall have a minimum ultimate 3-edge bearing strength upon testing of 1500 D.

TABLE VI

Interior Diameter of Pipe (Inches)	Minimum Wall Thickness (Inches)
12	2
15	2 1/4
18	2 1/2
24	3
30	3 1/2

The pipe shall be manufactured to all the requirements of these specifications, except the steel reinforcement will not be required.

SECTION - 105
(BLANK)

SECTION 106 - PIPE FOR SEWERS, DRAINS AND MISCELLANEOUS PURPOSES

106.1 Scope. This specification covers concrete pipe, and cast-iron pipe and fittings intended to be used for the conveyance of sewage, industrial waste, irrigation and storm water.

Non-reinforced concrete pipe, except Heavy Wall, shall not be placed under the highway roadbed.

106.2 Requirements. (a) Non-reinforced Concrete Pipe. Non-reinforced concrete sewer pipe shall conform to the requirements of the current AASHO Designation: M86; or Concrete Irrigation Pipe ASTM Designation: C118, when used for non-pressure drainage use, with the following exceptions:

(1) The aggregates for concrete shall conform to the requirements of Sections 85 and 88 of these specifications, except the grading requirements of fine and coarse aggregate may be waived.

(2) The pipe may be tongue and groove.

(b) Reinforced Concrete Sewer Pipe. Reinforced concrete sewer pipe shall conform to the requirements of Section 104 of these specifications.

(c) Cast-Iron Soil Pipe and Fittings. Cast-iron soil pipe and fittings shall conform to the current "Specifications for Cast-Iron Soil Pipe and Fittings," ASTM Designation: A74, with the following exceptions:

(1) All pipe and fittings shall be coated with coal-tar pitch.

(d) Welded Wrought-Iron Pipe. Unless otherwise shown on the plans or specified in the Special Provisions, water pipe and pipe for handrails shall be "Standard Weight" pipe Designation: M101. Pipe used as water pipe shall be galvanized and pipe used for hand railing shall be black.

SECTION 107 - TIMBER

107.1 Description. This specification covers general and specific requirements for structural timber, lumber, guard rail posts, guide posts, culvert and right-of-way markers and miscellaneous items constructed of Forest Products.

107.2 Species of Wood. The standard commercial and botanical names recognized by these specifications are described as follows:

Standard Commercial Name	Botanical Name
Cedar, Port Orford	Chamaecyparis lawsoniana
Fir, Douglas (Coast)	Pseudotsuga taxifolia (Coast Type)
Fir, Douglas (Inland)	Pseudotsuga taxifolia (Inter-mountain Type)
Hemlock, West Coast	Tsuga Heterophylla
Larch	Larix Occidentals
Redwood, California	Sequoia sempervirens

107.3 Grading Rules. Timber and lumber shall be of the grades shown on the plans, or as specified in these specifications or in the special provisions.

Douglas Fir (Coast) and West Coast Hemlock shall be graded in accordance with the current "Standard Grading and Dressing Rules for Douglas Fir and West Coast Hemlock", adopted by the West Coast Bureau of Lumber Grades and Inspection.

Redwood shall be graded in accordance with the current Standard Specifications for "Structural Grades of California Redwood Lumber", adopted by the California Redwood Association.

Port Orford Cedar shall be graded in accordance with "Export and Domestic Grading Rules No. 1 for Port Orford Cedar Lumber and Logs", reprinted and distributed by the Pacific Coast Lumber Association.

Western Larch and Douglas Fir (Inland) shall be graded in accordance with the current "Standard Grading Rules", adopted by the Western Pine Association.

107.4 General Requirements. The following general provisions apply to all stress-grades:

All material shall be well manufactured. Only pieces consisting of sound wood, free from decay will be accepted.

All sizes shown on the plans or specified in the special provisions applying to lumber and timber refer to nominal sizes, and the American Standard rough and dressed sizes shall be accepted as conforming thereto.

All timber to be used without preservative treatment shall contain not less than eighty (80) percent heartwood on any girth, or on any face, side or edge, measured at the point where the greatest amount of sapwood occurs.

For all timber to be pressure treated, there shall be no heartwood requirements, and the amount of sapwood shall not be limited.

All stress grades shall be free of heart center.

Slope of grain shall be measured over a distance sufficiently great to determine the general slope, disregarding slight local deviations. Within the middle half of the length of piece, the slope of grain shall not be steeper than specified in the grading rules. Green timber shipped by rail shall be adequately protected during transit from uneven seasoning. Stress-grades of Douglas fir shall be end coated with an approved protective coating at the time of manufacture.

Timber to be treated shall be cut, framed, and bored prior to treatment, unless otherwise shown on the plans or specified in the special provisions or permitted in writing by the engineer. When any framing, cutting, or boring of treated timber is permitted, all cuts, holes, etc., shall be thoroughly swabbed with three coats of the same preservative specified for the treatment of timber.

107.5 Inspection. Structural timber shall be subject to the inspection of the engineer at the site of the work, and rejected pieces shall be immediately removed from the work, by the contractor at his own expense.

Each shipment of untreated structural lumber, timber, and piling shall be inspected at the mill or at the dealer's yards by an inspector designated by the engineer and shall be accompanied by an inspection certificate showing the kind, character, amount, grade of material, name of mill supplying the material, the name and address of the inspector, the date of inspection, and any other pertinent data. One copy of the inspection certificate shall be attached to the car carrying the material or to the material itself in a position which will be readily accessible to the engineer. Copies of each certificate shall be forwarded in duplicate to the Department of Highways. The inspector shall stamp each piece of timber with a stamp which has been copyrighted and of which a true impression has been filed with the Department of Highways. Such stamp shall make a clear legible mark and shall designate the inspector and the grade of lumber. Surfaced material shall be inspected after surfacing.

Treated timber shall be inspected before treatment for grade and suitability by an inspector designated by the engineer. The inspector shall stamp the ends of each accepted piece with a suitable stamp which has been copyrighted and of which a true impression has been filed with the Department of Highways.

SECTION 108 - TIMBER PILES

108.1 Scope. This specification covers the quality of round timber piles.

108.2 Species. The species of timber used for timber piles shall be either Douglas fir, Southern Yellow Pine. Cedar or Larch.

The supplier of timber piles shall not mix species but shall supply different species in separate lots.

108.3 General Requirements. Timber piles shall conform to the requirements of the current "Specifications for Round Timber Piles", ASTM Designation: D25 for Class A piles and as follows:

(a) The piles shall be cut from sound live trees and shall be cut above the ground swell.

(b) Timber piles shall be free from any defects which may impair their strength or durability as piling, such as decay, red heart, splits in piles to be treated or splits longer than the measured butt diameter of the piles not to be treated, twist of grain exceeding one-half (1/2) of the circumference of any twenty (20) feet of length, unsound knots, numerous knots or holes, or a shake more than one-third (1/3) of the smallest diameter within its length, excessive turpentine scar or other impairment.

(c) Sound knots, not in clusters, will be permitted when the diameter of such knot or knots is within the limits hereinafter set forth:

For piles fifty (50) feet or under in length the diameter of such a knot shall not exceed one-third (1/3) the minimum diameter of the pile at the section where it occurs, provided, however, that in no case shall the diameter of the knot exceed four (4) inches. For piles over fifty (50) feet in length, the diameter of such knot between mid-length and the butt shall conform to the limitations set forth above for knots in piling fifty (50) feet or under in length and the diameter of such knot between the mid-length and the tip shall not exceed one-half (1/2) of the minimum diameter of the pile at the section where it occurs, provided that in no case shall the diameter of the knot between the mid-length and the tip of the piles over fifty (50) feet in length exceed five (5) inches.

(d) Piles shall have a gradual taper from tip to three (3) feet below butt.

(e) All knots and limbs shall be neatly trimmed flush with the surface of the pile. Unless otherwise provided, butts shall be sawed square with axis of the pile and tips shall be tapered to a point not less than four (4) inches square all such cuts on treated piling shall be made before treating.

(f) Piles for use without preservative treatment shall have as little sapwood as possible. The diameter of the butt heart ring shall be not less than eighty (80) percent of the butt diameter.

(g) Piles for use with preservative treatment shall have no sapwood restrictions but preferably shall contain as much sapwood as possible. In Douglas fir and Larch and the sapwood rings shall be not less than one (1) inch at the butt.

(h) Piles for use with or without preservative treatment shall be peeled of bark (including the inner skin) soon after cutting so that the piles are smooth and clean. No piles shall be considered as peeled unless all of the rough bark and at least eighty (80) percent of the inner bark has been removed, provided, that in no case shall any piece of inner bark, left on the pile be over three-quarters (3/4) inch in width or over eight (8) inches in length and there shall be at least one (1) inch of clean wood surface between any two strips of inner bark.

(i) Care shall be taken to remove as little sapwood as possible while peeling the bark. The sapwood shall not be injured by unnecessary axe cuts. The bark on piles for use with preservative treatments shall be removed as above described before the piles are treated.

(j) The diameter of the pile shall be measured three (3) feet before the square cut butt such that in any case not more than twenty-five (25) percent of the piles of that diameter are not more than one-half (1/2) inch less. The diameter of a pile in cases where the tree is not exactly round shall be determined either by measuring the circumference and dividing the number of inches by 3.14, or by taking the average of the maximum and minimum diameters with callipers.

(k) Piles shall be furnished cut to two (2) foot multiples in lengths of sixteen (16) to forty (40) feet; in lengths over forty (40) feet, lengths in multiples of five (5) feet. The length shall be legibly painted on each butt.

(l) Any line drawn from center of tip to butt center shall lie within the taper. Piles shall be free from short or reversed bends; and crooks shall not exceed one-half (1/2) the pile diameter at the middle of the bend.

108.4 Inspection. Inspection certificates shall be furnished without extra charge with each shipment of timber piles. These certificates shall be issued by the inspection agency under whose rules the material was manufactured and graded.

Timber piles to be treated shall be inspected prior to treatment by an inspector designated by the engineer. The inspector shall stamp each pile on the butt end with a stamp which shall make an impression that is readily legible after treatment. The stamp shall be copyrighted and a true impression filed with the Division of Highways.

Commercially treated piles from stock may be used for test piles. Where commercially treated piles are permitted, stamping the piles by the inspector before treatment will not be required.

SECTION 109 - TIMBER PRESERVATIVES

109.1 Scope. This specification covers the quality of Creosote, Creosote-Coal Tar Solutions, Creosote-Petroleum Solution, Water-Borne Preservatives, Oil-Borne Preservatives, and Preservative Oils for Non-Pressure Treatments.

109.2 Preservatives. Preservatives used shall be as specified herein, shown on the plans or as specified in the Special Provisions and shall conform to the following current AWPA Manual Standards:

Creosote	P-1
Creosote-Coal Tar (Type A)	P-2
Creosote-Petroleum	P-3 & P-4
Water - Borne	P-5
Oil - Borne	P-8 & P-9
Preservative Oil for Non-Pressure Treatment	P-7

109.3 Sampling and Testing. Preservatives shall be sampled and tested in accordance with the following current standard methods:

Analysis of Creosote	AWPA A-1
Analysis of Water - Borne Preservatives	AWPA A-2
Sampling of Creosote	AASHO T-60
Analysis of Oil - Borne Preservatives	AWPA A-5
Analysis of Chemonite	Fed. Spec. TT-W-549

SECTION 110 - FENCE POSTS AND FENCE MATERIALS

110.1 Scope. This specification covers the quality of barbed wire, woven wire and chain-link fabric fencing, fence posts, gates and miscellaneous fence hardware.

110.2 Wood Posts. Unless otherwise provided in the special provisions, wood posts may be treated or untreated material at the contractor's option. If treated wooden posts are used, treatment shall conform to the requirements for creosote or creosote solution, as set forth in Article 52.4 of these specifications. Without expense to the department, a certificate covering each order shall be furnished by the treating company, to the engineer, certifying that the posts and treatment comply with these specifications.

(a) End, Corner, Gate and Intermediate Braced Posts shall be sawed posts conforming to the grading requirements of Article 49.4 of these specifications and of the dimensions shown on the Standard Plan. Treated posts shall be either Douglas Fir, Larch, Hemlock or Southern Pine and untreated posts shall be Port Orford Cedar, Western Red Cedar, or construction heart Redwood.

(b) Untreated line posts may be split posts, round posts or sawed posts of construction heart Redwood, Western Red Cedar, Port Orford Cedar, manufactured from sound, live trees, well seasoned and free from large knots, shakes or splits or other defects which will impair their strength or durability. Round and split posts shall be free of all bark. Round posts shall be not less than four (4) inches in diameter measured at the small end. Split posts may be triangular, quadrangular or half-round and shall not be less than seventeen (17) inches in circumference (if triangular shaped the smaller face shall be not less than four (4) inches), and if they are four sided the sum of the widths of the two smaller faces shall be not less than (6) inches.

(c) Treated line posts may be split posts, round posts, sawed or sawn segmented posts of Douglas Fir, Southern Pine, Ponderosa Pine, Jack Pine, Lodgepole Pine, Red Pine, West Coast Hemlock or Larch, manufactured from sound live trees, well seasoned and free from large knots, shakes or splits or other defects which will impair their strength or durability. The posts shall be free of all bark. Round posts shall be not less than four (4) inches in diameter, measured at the small ends. Split or sawn segmented posts shall be not less than fourteen (14) inches in circumference (if triangular shaped the smaller face shall be not less than four (4) inches), and if they are four sided the sum of the widths of the two smaller faces shall not be less than six (6) inches.

The style of posts shall not be mixed on any one project but shall be either all split, round, sawn segmented or sawed posts throughout the project.

(d) Bracing for timber posts shall be untreated and may be Douglas Fir, Larch, Western Hemlock or Southern Pine of the quality set forth in Article 49.4 of these specifications and of the dimensions shown on the Plans.

110.3 Metal Posts. Tubular posts shall be galvanized standard-weight steel pipe conforming to the requirements of the current "Standard Specification for Black and Hot-Dipped Zinc (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses", ASTM Designation: A120, except that the hydrostatic test will not be required.

The base metal for the manufacture of other steel sections used for posts and braces shall be good commercial quality weldable steel.

A-7 2-1-66
C-1135

Posts and braces shall conform to the following requirements:

For Chain-Link Fence 72 Inches and Less

Location	Type	Min. Size (greatest dimension)	Min. Weight pounds per linear foot
End, Corner and Pull	Pipe	2.351 O.D.	3.10
Line	Pipe H-Section	1.869 O.D. 1.815	2.31 2.66
Braces	Pipe H-Section	1.630 O.D. 1.44	1.93 2.16
Gate-Single to 6 ft. or double to 12 ft. incl.	Pipe	2.351 O.D.	3.10
Gate-Single over 6 ft. to 13 ft. or double over 12 ft. to 26 ft. incl.	Pipe	3.960 O.D.	8.65
Gate-Single over 13 ft. to 18 ft.	Pipe	6.599 O.D.	18.02

For Standard Type A Fencing

Location	Type	Min. Size (greatest dimension)	Min. Weight pounds per linear foot
End, Corner Pull and *Gate	Pipe	2.351 O.D.	3.10
Line	T or H-Section	----	1.3
Braces	Pipe	1.630 O.D.	1.93

*Size of gate posts shall be as set forth for chain link fence (see table)

Line posts for Type A fencing shall be galvanized or painted with anti-corrosive paint. The posts shall be drilled, notched or studded to

facilitate fastening the fence and shall be provided with a suitable anchor plate. Each post shall be furnished with not less than seven (7) galvanized wire clamps.

110.4 Fencing. (a) Barbed Wire Fencing. Barbed wire shall be composed of two (2) strands of No. 12-1/2 steel wire gage size copper-bearing wire with four (4) point twelve and one-half (12-1/2) gage barbs spaced not more than five (5) inches apart. The barbed wire shall conform to the requirements of the current "Standard Specification for Zinc-Coated (Galvanized) Iron or Steel Barbed Wire", ASTM Designation: A121, Class 2.

(b) Woven Wire Fencing. Woven Wire shall be galvanized style No. 12-1/2 farm fencing conforming to the requirements of the current "Specifications for Zinc-Coated Wire Fencing", ASTM Designation: A 116. The top and bottom wires shall be ten (10) gage and the intermediate line wires and vertical stay wires shall be twelve and one-half (12-1/2) gage. The heighth of the fabric and the number of horizontal wires shall be as designated by the design number appearing on the standard plan and in the proposal with continuous vertical stays spaced six (6) inches apart.

(c) Chain-Link Fencing. Chain-link fence fabric shall conform to the requirements of the current "Standard Specifications for Zinc-Coated Iron or Steel Chain-Link Fence Fabric Galvanized After Weaving", ASTM Designation: A117. The wire used in the manufacturer of the fabric shall be eleven (11) gage for all fence seventy-two inches or less in heighth.

All chain-link fence fabric shal l be woven into approximately two (2) inch mesh. Chain-link fence fabric shall have twisted and barbed finish on both edges for widths of sixty (60) inches or over, the top edge projecting over the top tension cable of the fence, forming a barbed protection. Barbing shall be done by cutting the wires on the bias. Fabric less than sixty (60) inches wide shall have knuckled finish on the top edge and twisted and barbed finish on the bottom edge.

110.5 Staples, Brace Wire and Nails. Brace Wire shall not be less than No. 9 B & W gage size copper-bearing wire conforming to the requirements of the current "Standard Specification for Zinc-Coated Tire Wire," ASTM Designation: A112.

Staples shall be made from No. 9 U.S. Steel Wire gage galvanized wire and shall be one and one-half (1-1/2) inches long.

Nails and spikes shall be new, standard, material of such sizes and kinds as are shown on the Standard Plan.

110.6 Metal Gates. (a) Drive Gates for Standard Fencing. The gate frames shall be constructed of not less than one (1) inch galvanized standard weight pipe conforming to the dimensions, nominal weights, and galvanizing specified in the current ASTM Designation: A53. Galvanized tubular steel braces shall be placed vertically in each gate, and corner and brace joints shall be so secured that the gate will retain a true

rectangular shape.

The wire mesh shall be rectangular mesh or two (2) inch diamond mesh and shall be galvanized in accordance with the requirements herein specified for woven wire fabric.

(b) Drive Gate for Chain-Link Fencing. The gate frame shall be constructed of not less than one and one-half (1-1/2) inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under the current ASTM Designation: A53. Gate frames shall be cross-trimmed with galvanized three-eights (3/8) inch adjustable truss rods. The corners of the gate frames shall be fastened together and reinforced with malleable iron fittings designed for the purpose of welding.

Chain-link fence fabric as specified for the fence shall be attached to the gate frame by the use of stretcher bars and tie wires as specified for fence construction, and suitable tension connectors spaced at approximate one (1) foot intervals.

(c) Walk Gates. Unless otherwise specified, walk gates shall be three and one-half (3 1/2) feet wide and of the height corresponding to the adjacent fence.

The gate frame shall be constructed of not less than three-quarter (3/4) inch galvanized standard weight pipe conforming to the dimension, nominal weights, and galvanizing specified under the current ASTM Designation: A53.

The gate frame shall be filled with fabric meeting the requirements for fabric as specified herein.

The gate shall be furnished complete with approved hinges, latches and auxiliary braces as required.

110.7 Timber Gates. Timber gates shall be constructed from Douglas Fir, Western Hemlock, Southern Pine or Larch, conforming to Section 49, and in accordance with the design, dimension and detail shown on the Standard Plan.

SECTION 111 - GUARD RAIL MATERIALS

111.1 Material Covered. This specification covers the materials for use in the construction of guard rail.

111.2 General Requirements. Before any type rail is used, the manufacturer's plans and specifications shall be submitted and approved by the engineer, and such plans shall be used in conjunction with the standard erection plans. Manufacturer's plans shall show full details of all assemblies.

Sampling and testing shall be done in accordance with standard recognized practice for the units described herein or to the specific method as indicated.

Guard rail parts furnished under this specification shall be interchangeable with similar parts regardless of the source or manufacturer.

Upon request the contractor shall furnish the engineer with specimens of rail and fittings for testing purposes free of charge.

Two certified copies of mill test reports showing the chemical and physical characteristics from each heat from which metal is used shall be furnished by the contractor.

111.3 Rail Element. The rail element shall be made from steel plates which shall conform to the current requirements of ASTM Designation: A107 for carbon steel of grade 1035 to 1050 which specifies a maximum carbon content of fifty-five hundredths (0.55) percent. In addition, a two (2) inch test specimen of the steel shall elongate not less than twelve (12) percent.

The rail element shall be shop fabricated into a beam by corrugating the plate longitudinally. The finished beam shall not be less than twelve (12) inches wide and shall be of a length equal to the post spacing plus an additional length for lapping at joints. The minimum thickness of metal in the plate shall be No. 12 gage (4.375 pounds per square foot), unless otherwise specified.

Rail elements shall be designed to meet the requirements of the following table:

Minimum Gage	Rail or Joint Tensile Strength (Pounds)	Beam Strength *			
		Traffic Face Up		Traffic Face Down	
		Load (Pounds)	Maximum Deflection (Inches)	Load (Pounds)	Maximum Deflection (Inches)
12	80,000	1500 2000	2 3/4 5 1/2	1200 1600	2 3/4 5 1/2
10	100,000	2000 3000	2 3/4 5 1/2	1600 2400	2 3/4 5 1/2

*With the rail element freely supported on 12 feet 0 inch clear span and the load applied through a 3 inch flat surface at the center of the span. When the joint is tested it shall be at the center of the span.

The rail element shall be spliced at each post by lapping in the direction of traffic. The holes in the plate nearer the post shall be slotted to facilitate erection and to permit expansion.

On curves of one hundred fifty (150) foot radius or less, the rail plates shall be shop curved as required. The radii of curvature shall be in increments of twelve feet 6 inches from a radius of one hundred fifty (150) to fifty (50) feet inclusive and in increments of six (6) feet from a radius of fifty (50) feet to and including twenty (20) feet.

Where the rail is on a curve the plates at the splice shall make contact throughout the area of the splice, forming the beams before erection is necessary.

The edges of the beam shall be rolled or rounded so that they present no sharp edges. The projecting heads of all connection and splice bolts shall be rounded and shallow so that no appreciable projection will obstruct a vehicle sliding along the rail.

The beams shall be either galvanized or painted in accordance with the requirements specified herein.

111.4 Offset Brackets. Offset brackets may or may not be required depending upon the design of the beam element:

No offset brackets will be required for beams having a depth of three (3) inches or more providing the edges of the plate make contact with the post. If the edges of the plate do not make contact with the post, they shall be horizontally supported by a metal offset bracket which may or may not be resilient.

Non-resilient offset brackets shall be made from cast iron or malleable cast iron and shall be of a design, dimension and weight specified or as approved by the engineer.

The brackets shall be galvanized in accordance with the requirements specified herein.

111.5 End Details. A short portion of the rail known as the end plate shall project beyond the outside edge of each end post. This plate shall be of the same gage as the rail, shall be securely fastened to the post and rail and shall be bent back from the front line of the rail upon an approximate radius indicated on the plans. Where end posts are adjacent to bridge end posts or railings, it may be directed that the end plate be omitted.

111.6 Fittings. The fittings shall be of the dimensions and material shown on the plans. All metal fittings including bolts, nuts, and washers shall be galvanized.

111.7 Shop Fabrication. All parts of the guard rail shall be fabricated and holes drilled in the shop ready for immediate and complete installation. No punching, cutting, burning or welding will be permitted in the field. Holes for special details in exceptional cases may be made in the field when

approved in writing by the engineer, but such holes shall be drilled.

111.8 Shop Finish. The materials shall be galvanized or painted as specified herein:

(a) All metal other than beam elements shall be galvanized after fabrication to meet the current "Specifications for Zinc, (Not-Galvanized) Coatings on Structural Steel Shapes, Plates and Bars and their Products, ASTM Designation: A123

(b) All metal not required to be galvanized shall, after fabrication, be cleaned to a steely brightness and painted in the shop with a coat of approved red lead primer or approved zinc chromate primer as prescribed in Section 51.

111.9 Posts. Wood posts shall conform to the requirements for guard rail posts as specified under Section 71.

SECTION 112 - EXPANSION JOINT FILLER

112.1 Scope. This specification covers the quality of pre-formed expansion jointsfillers.

112.2 General Requirements. Pre-formed expansion joint filler shall conform to the requirements of the current "Standard Specifications for Preformed Expansion Joint Fillers for Concrete", AASHO Designation: M-153

Chute -Dec 1-14-60

SECTION 113

(BLANK)

SECTION 114 - CURING AGENTS FOR CONCRETE

114.1 Scope. This specification covers concrete curing agents of burlap, cotton mats, paper blankets, liquid membrane material, and water. The curing agents shall be free from any impurities which may be detrimental to the surface of concrete and shall conform with these specifications.

114.2 Burlap. Burlap shall be either new or have been used only for the curing of concrete. New burlap containing stiffening agents shall be washed clean before using. The burlap shall weigh not less than twelve (12) ounces per ten (10) square feet when dry. It shall be of such length that when laid it will extend at least twelve (12) inches beyond the edges of the concrete slabs.

114.3 Cotton Mats. Cotton mats shall meet the requirements of the current "Standard Specifications for Cottom Mats for Curing Concrete", AASHO Designation: M73.

114.4 Waterproof Paper. Waterproof paper shall meet the requirements of the current "Standard Specifications for Waterproof Paper for Curing Concrete", AASHO Designation: M139.

114.5 Nonbituminous Liquid Compounds. Nonbituminous liquid curing compounds (liquid membrane) shall meet the current "Standard Specifications for Nonbituminous Liquid Compounds for Curing Concrete", AASHO Designation: M148, except as hereinafter set forth:

(a) The curing compound shall not react harmfully with the components of concrete or contain oils, waxes or other materials which would prevent bonding of traffic marking paints or compounds used for sealing expansion and contraction joints. The resulting film shall be continuous, uniform, and free from pinholes, bubbles, or blisters.

(b) The curing compound shall be clear or translucent and contain a fugitive dye to assist in securing uniform coverage. The color shall remain visible for at least one (1) hour after application. The color of the fugitive dye shall disappear within seven (7) days after application.

(c) The curing compound shall be of such viscosity that it may be readily applied by approved pressure spraying equipment at temperatures above forty (40) degrees F.

(d) When applied by pressure spray to the troweled surface of a vertical, damp concrete specimen, one (1) foot square, at the rate of two hundred (200) square feet per gallon, the curing compound shall adhere to the surface in a continuous, tenacious film without running off or appreciable sagging. In spraying the specimen the nozzle of the spray shall be held between four (4) and six (6) inches from the surface of the specimen.

(e) The membrane shall not peel; it shall disappear from the surface by gradual disintegration from exposure to the elements over a period of not less than thirty (30) days nor more than one (1) year, leaving the concrete hard and without discoloration.

(f) Curing material shall be supplied only in clean containers that are in good condition. It shall be delivered to the job in the manufacturer's original container, which shall be clearly marked with the manufacturer's name, trade name of the material, and batch number or symbol by which samples submitted for testing purposes may be identified.

(g) All curing compounds shall be tested by the department and shall not be used until written notification of their approval has been received from the laboratory. A sample of at least one (1) quart of any curing compound proposed for use shall be sent to the State Highway Engineer, State Office Building, Carson City, Nevada for preliminary tests, at least fifteen (15) days before the proposed date of use. No shipment of liquid membrane seal shall be used unless it complies fully with the requirements of the specifications.

114.6 Water. Water used in curing of concrete shall meet the requirements of Section 80.

INDEX TO STANDARD SPECIFICATIONS

INDEX

A

Page No.

Abbreviations----------1
Acceptability of materials----------24
Acceptance and Final Payment----------54
Accomodations for Public Traffic----------56
General requirements----------56
Materials----------56
Barricades and Warning Signs----------60
Measurement and payment----------61
Adjustments, common carrier rates----------52
Adjustment of contract time----------45
Adjustment of Haul on local material----------53
Adjustment of unit prices----------14
Admixtures for concrete----------156
Agencies, federal----------33
Aggregates (see various sections covering)----------319-329, 331-334
Allowable deviation from plans----------18
Alternate methods of Handling traffic----------61
Alterations of plans & specifications----------13
Alterations, rejection of proposals containing----------9
Altered quantities, payment for----------13
Anchorage, steel structures----------202
Annealing steel----------200
Annulment of contract----------46
Application of Bituminous Binders, temperatures, etc.----------112
Approximate estimate----------8
Aprons, concrete----------266
Armor Coat----------128
Construction Methods----------128
Equipment----------128
Materials for----------324
Coarse aggregate----------324
Emulsified Asphalt----------340
Key Rock----------324
Liquid Asphalt----------335
Screenings----------324
Water----------318
Measurement and payment----------129
Asphalt materials-
Cements----------344
Emulsions----------340
Joint filler----------347
Liquid asphalts----------335
Waterproofing----------348
Assignment of contract----------42
Authority of Engineer----------17
Authority and duties of inspector----------20
Award and execution of contract----------11
Award of Contract----------1, 11

Award, cancellation of----------11

B

Backfill----------95
General requirements----------95
Materials----------95
Measurement----------96
Payment----------97
Placing----------96
Barbed wire----------374
Bar reinforcement----------352
Barricades and Warning signs----------60
Bars, lacing for steel structures----------199
Bars, raised traffic----------281
Base courses----------107
Batch mixing (PMS)----------145
Beam scales----------145
Bearings and anchorage----------202
Bearing value, piles----------214
Bidder----------1
Bond----------9
Competency of----------7
Collusion among----------10
Disqualification of----------9
Examination of plans, etc.----------8
Financial statement of----------7
Guaranty----------9
Prequalification of----------7
Bids-
Conditional----------10
Incomplete----------9
Rejection of----------8
Time and place of opening----------9
Preparation of----------8
Qualification of----------10
Unbalanced----------9
Withdrawal or revision of----------9
Bituminous Binders-
Application of----------112
Conversion tables----------117-120
Equipment----------113
Measurement of----------115
Temperature of application----------114
Weather Conditions----------113
Weights, Volumes of----------116
Bituminous Treated Footpaths----------260
Blasting----------37, 75
Blotter sand----------333
Bolted connections, steel structures----------194
Bolts and rivets----------194
Bonds, bidders----------4, 9
Bonds contract----------2,11

Borrow----------79
Borrow, selected----------81
Bridges-
Concrete (see structures)----------169
Definition of----------1
Steel (see structures)----------190
Timber (see structures)----------206
Bronze----------351
Brush, removal of---------- 63
Buildings, protection of----------36
Buildings, removal of----------69
Burning regulations----------40

C

Cable for Chain Link fence----------270
Calendar Day----------1
Camp sanitation----------55
Carrying traffic through construction operations----------58
Cast-in-place concrete----------218
Castings-
Gray iron----------351
Malleable----------351
Steel----------351
Catch basins, inlets and manholes----------252
Cement, asphaltic----------344
Cement, Portland----------349
Chain link fence----------269
Changed conditions----------13
Channel excavation, ditch and----------74
Character of workmen, methods and equipment----------44
Claims against contract----------54
Classes of Portland cement concrete----------156
Clay pipe----------357
Cleaning and relaying pipe culverts----------246
Cleaning for painting (see painting)----------222
Cleaning up, final----------16
Clearing and Grubbing----------63
Areas to be cleared----------63
Cofferdams----------92
Cold weather work, concrete----------165
Collusion among bidders----------10
Commencement of work----------43
Common Carrier Rate adjustments----------52
Compacting of embankments----------86
Compacting equipment for embankments----------88
Compacting natural ground----------85
Compaction, relative----------28, 85, 89, 95, 108
Competency of bidders---------- 7
Completion of work, time of----------43
Computed weights of structural steel----------203
Concrete pipe culverts (see pipe culverts, concrete)----------237

Concrete, Portland cement----156
Admixtures----156
Aggregates plant----158
Aggregates, grading of----328, 331
Aggregates, proportioning of----159
Cement----349
Classes of----156
Coarse aggregate----327
Cold weather work----165
Curing (see type of work involved)----179
Delivery standard form of report of----168
Deposited under water----176
Fine aggregate----331
Low-alkali cement----349
Materials----156
Mixing-hand----163
Mixing-machine----162
Ready-mixed----163
Sand----331
Shrink-mixed----163
Slump, test for----162
Structures----169
Transit-mixed----163
Tremie----177
Water, amount of----162
Water, Requirements for----318
Waterproofing----184
Vibrators----173
Concrete bridges and structures----169
Concrete culverts----175
Concrete deposited under water----176
Concrete, removal of----69
Concrete slope paving and aprons----266
Conditional bids----10
Conditions, changed----13
Conditions, Bidding requirements and----7
Conditions of Employment, Wages and----55
Conformity with plans and allowable deviations----18
Connection angles for steel structures----199
Connections and road approaches----73
Construction-
Joints----177
Maintenance during----22
Stakes, preservation of----20
Contents of proposal forms----7
Continuous mixers----147
Contract-
Assignment of----42
Award----11
Bond----11
Claims against----54
Completion of----47
Default and annulment----46
Definition of----2

Contract, continued-
Execution and approval of----12
Failure to execute----12
Intent of----13
Subcontracting----42
Termination----47
Time, award of----11
Time, determination and extension of----45
Contractor-
Cooperation of----19
Financial statement of---- 7
Liability Insurance----37
Licensing of---- 7
Protest of----14, 17
Prequalification of---- 7
Responsibility for damage----37
Responsibility for work----39
Responsibility, termination of----47
Control of material----24
Control of work----17
Convenience of traffic----56
Conversion tables for asphaltic emulsion----120
Conversion tables for liquid asphalts and asphalt cement----117-119
Convict labor---- 44
Cooperation between Contractors----19
Cooperation with utility forces----20
Coordination of plans, specifications and special provisions----18
Corrugated metal pipe culverts (see pipe culverts corrugated)---233
Corrugated metal pipe underdrains----248, 329, 356
Costs of tests----27
Culvert headwalls, removing and resetting----247
Culvert markers----275
Culverts-
Cleaning and relaying pipe----246
Concrete----237
Corrugated metal pipe----233
Extending pipe----235
Non-reinforced concrete pipe----242
Salvaging existing----66
Structural Plate culverts----244
Strutting Pipe----234
Curbs, gutters and sidewalks----262
Construction of curbs and gutters----263
Construction of sidewalks----265
Driveways----264
Forms----262
Joints----263
Local depressions----264
Subgrade----262
Curing Agents for Concrete----379
Cuts, widening of---- 76
Cutting steel----198

D

Damage, responsibility for----------37
Damage, liquidated----------46
Damage to trees----------36
Day, definition of calendar---------- 1
Day, definition of working----------5
Decreases of items----------13
Defective materials----------30
Defective work, removal of----------21
Definitions and terms----------1-6
Delays in completion of work----------39,45
Detours, maintenance of----------60
Deviations from plans, allowable----------18
Dikes, shoulder----------153
Discrepancy between drawings and figures----------19
Disposal of structures and obstructions----------66, 69
Disputes, settlement of----------17
Disqualifications of bidders----------9
Ditch and channel excavation----------73
Douglas fir timber---------- 206, 366
Downdrains, embankment protectors and----------250
Drain tile----------248
Drawings, working----------17
Drilled holes, steel structures----------193
Driveways----------264
Driving piles, equipment for----------212
Drying aggregates----------133, 149

E

Electrical facilities, removal of----------39
Electrical work (see signals and lighting)----------283
Embankments----------85
Embankments-
Compaction of----------88
Construction of----------86
Maintenance of----------89
Materials----------86
Measurement and payment----------89
Preparation of ground for----------85
Embankment protectors, metal----------250
Employment, Wages and Conditions of----------55
Emulsions, asphaltic----------343
End sections, flared----------234
Engineer, authority of----------17
Engineer, orders by----------17
Equipment-
Compacting----------103, 148
Pile driving----------212
Weighing----------49
Equipment and plant (PMS)----------143
Equipment and Plant (PCC)----------158
Estimate, progress----------53

Excavation-
Below Grade----74
Blasting----75
Borrow----79
Ditch and Channel----74
Haul of----84
Loose rocks and boulders, removal of----74
Measurement of ----76
Overshooting of----75
Payment of----77
Roadway and Drainage----73
Reserve material----76
Slides----75
Slopes----76
Unsuitable materials----74
Widening cuts----76
Execute contract, failure to----12
Execution of contract, award and----11
Existing improvements, removal of----66,69
Expansion joints-
Concrete curb and gutters and sidewalks----262
Concrete slope paving----266
Explanations by Engineer----17
Explosives, use of----37
Extending corrugated metal culverts----235
Extension of time for completion----45
Extra work and force account work----15
Eyebars, steel structures----205, 350

F

Fabric, waterproofing----185
Facilities, underground----39
Facing of steel bearing surfaces----198
Failure to execute contract----12
Fair labor standards act----33
Faithful performance bond----11
Falsework-
Concrete structures----172
Removal of----178
Steel structures----201
Federal agencies----33
Federal aid projects, inspection of----33
Fencing----268
Fencing-
Chain link----269, 372
Existing----69
Gates----270, 372
Reconstructed----270
Standard----268, 372
Wire----374
Field Laboratory----29, 317
Fill (Embankment)----85
Filler, expansion joints----347

Filter material for underdrains----------329
Final cleaning up----------16
Final inspection----------22
Final payment----------54
Financial statement, bidders----------7
Finish surface for concrete structures----------182
Finishing slopes----------76
Fir, Douglas----------206, 366
Fire, prevention and control of----------40
Flagman, payment for----------61
Flared end sections----------234
Footings, depth of----------169
Force account work----------15
Forfeiture and proposal guaranty----------9
Form clamps----------171
Forms-
    Concrete curbs, gutters and sidewalks----------262
    Concrete structures and falsework----------169
Forms, proposal----------7
Foundation-
    Excavation----------91
    Fill----------98
Framing timber structures----------208
Free haul----------84
Fuel Tax, refund----------10

G

Gage, magnetic thickness----------224
Gates----------374-375
Grades and lines, marking and maintaining----------20
Grading, earthwork----------73
Grading of aggregates ----------319-329, 331-334
Gravel Base Courses-
    Materials----------107
    Measurement of----------108
    Payment of----------108
    Placing----------107
    Wetting and Compaction----------108
Grubbing, clearing and----------63
Guaranties, return of proposal----------9
Guaranty-
    Bidders----------4,9
    Forfeitures of----------9
    Material----------10
    Proposal----------4,9
Guard rail----------272, 376
Guide posts and culvert markers----------275
Gutters (see curbs, gutters and sidewalks)----------262

H

Hardware for timber structures----------353
Haul, free----------84
Headwalls, removing and resetting----------247

Heavy riprap----254
Holidays----3

I

Illuminated signs (see signals and lighting----283
Improvements, existing
Highway----66
Removal of----69
Salvaging----69
Utility facilities----39
Incomplete bids----9
Increases or decreases of items----13
Information available to bidders----7
Injury to persons----37
Injury to work, Contractors responsibility for----39
Inlets, catch basins, manholes and----252
In-place material for road mixing----131
Inspection of materials----30
Inspection of plant----26
Inspection of work by federal agencies----33
Inspection, final----22
Inspectors, authority and duties of----20
Interpretation of plans and specifications----18
Iron castings----351
Iron plates, wrought----351
Irregularities, rejection of proposal containing----9
Irrigation pipe, concrete----365
Items, increases or decreases of----13

J

Joints-
Abutting, of steel structures----198
Concrete structures----177,180
Expansion, curbs, etc.----262
Sidewalks----262
Slip for down drains----250
Slope pavement----266

L

Labor and material bond----11
Laboratory, Field----29, 317
Labor, fair labor standards act----33
Labor, hours of----55
Lacing bars for steel structures----199
Laws to be observed----32,55
Legal Relations and Responsibility----32
Legal Relations and Responsibility-
Contractor's responsibility for work----39
Explosives----37
Fair labor standards act----33
Federal participaction----33

Legal relations and responsibility- Continued-
Fire prevention and control----40
Laws to be observed----32,55
Legal rights, no waiver of----40
Liability insurance----37
Patents----32
Permits and licenses----32
Personal liability of public officials----40
Preservation and restoration of property and landscape----36
Public convenience and safety----33
Registration of contractors----7
Relations with Railroads----34
Relief from maintenance----38
Responsibility for damage claims----37
Responsibility for public or private utility properties----39
Redaponsibility for work----39
Restoration of surfaces opened by permit----33
Sanitary provisions----33
Sections open to traffic----58
Liability of contractor----37
Licenses, permits and----32
Licensing of contractors----7
Lights, public safety----57
Light, stone riprap----254
Lighting (see signals and lighting)----283
Lines and grades, marking and maintaining----20
Liquid asphalts----335
Liquidated damages----46
Load and speed restrictions----22
Local borrow----79
Lowest bidder, award to----11
Lumber----366

M

Magnetic thickness gage----224
Maintaining traffic----58
Maintenance during construction----22
Maintenance of detours----60
Maintenance of embankments----89
Maintenance, relief from----38
Malleable castings----351
Manholes, inlets, catch basins and----252
Markers, guide posts and culvert----275
Markers, monument----280
Markers, right of way----279
Masonry, rubble----257
Masonry, stone for----330
Material and labor bond----11
Materials----24
Materials-
Control of----24
Defective----30
Guaranty for----10

Materials - Continued-
Handling----30
Inspection of----21,30
Local----24
Measurement of----48
Plant Inspection----26
Property rights in----24
Responsibility for----24
Sites for local materials----24
Source of supply and quality of----24
Storage of----30
Standard form of Release of----31
T Tests, samples and----27
Tests, special methods of----27
Unsuitable----74
Weighing----49
Measurement and Payment (also see sections for the various items of work-)----48
Mesh reinforcement----352
Mesh for wire fencing----374
Metal, structural, for timber structures----208
Mixing concrete----172
Mixing type emulsion----342
Moneys, retention of----53
Monuments----280
Mortar for rubble masonry----257
Motor Fuel Tax Refund----10
Moving and resetting culvert head walls----247

N

National Electrical code----283
National Electrical Manufacturers Association----283
Non-reinforced concrete pipe----242

O

Obstructions, Removal of----75
Omissions and alterations----52
Opening bids, time of----7
Order of preference, plans and specifications----18
Orders by Engineer----17
Overhaul----84
Overhead electric line construction, rules of----283
Overshooting----75
Oversize rocks and lumps----131

P

Paint----221
Painting----221
Painting-
Application----222-225

Painting- Continued-
cleaning surfaces----222-225
Concrete and concrete masonry----225
Frames and grates----225
Hand cleaning----223
Preparation of surface----222-225
Protection----222
Rust-inhibitor chemical washes----223
Sandblasting----222
Structural steel----224
Tables, formula or specification----227-230
Timber----225
Paints for steel----227,228
Paints for timber----229
Paints for metal guide posts & culvert markers----276
Partial payments----53
Patents----32
Payment, measurement and (see sections for various items of work)
Payment-
Altered quantities----13
Extra work and force account----51
Final and acceptance----54
Omitted Items----52
Partial----53
Scope of----50
Payments, deductions from----54
Penetration of piles----214
Penetration type emulsion----341
Perforated metal pipe underdrains----248,356
Permits and licenses----32
Permit, Restoration of surface opened by----33
Personal liability of public officials----40
Persons, responsibility for injury to----37
Pigmented sealing compound----282
Piling----212
Piling-
Bearing value----214
Cast-in-place concrete----218
Cut-off and extensions----215
Dimensions of timber----368
Driving----212
Driving equipment----212
Lengths of----216
Load test----216
Materials----212
Measurement and payment for----219
Inspection----218
Penetration of----214
Precast concrete----217
Steel piles----218
Test piles----218
Timber piles----216
Treatment of pile heads----217
Pilot car----56-58

Pin connections for steel structures----------203
Pipe, clay----------357
Pipe culverts, concrete----------237
Pipe culverts, concrete-
Backfill methods----------237
D-load----------358-364
Drainage----------242
Field joints for siphons----------240
Flared end sections----------241
Irrigation pipe----------242
Laying pipe----------239
Measurement and payment----------241
Non-reinforced pipe----------242
Rubber gasket joints----------240
Self-centering joints----------240
Sewer pipe----------365
Siphons----------240
Wall thicknesses----------358-364
Pipe culverts, corrugated metal----------233
Pipe culverts, corrugated metal-
Accepted brands of metal----------354
Backfilling----------235
Cleaning and relaying----------246
Close rivetted and soldered----------235
Corrugated metal pipe----------354
Coupling bands----------354
Damaged coating----------233
Dimensions and weights----------354
Downdrains----------250
Embankment protectors----------250
End finish----------234
Extending culverts----------235
Flared end sections and headwalls----------234
Measurement of----------235
Payment of----------236
Perforated metal pipe----------356
Placing----------233
Protective coating----------235, 355
Removing----------66
Salvaging pipe----------67
Siphons----------234
Strutting----------234
Underdrains----------248
Place of opening bids----------9
Plans-
Allowable deviations----------18
Alterations----------18
Conformity with----------18
Coordination with specifications and special provisions----18
Examination of----------8
Interpretation of----------18
Shops----------18
Specifications, order of preference----------18

Plans- Continued-
Working drawings----17
Plant Inspection----26
Plant-mixed surface----143
Plant-mixed surface-
Aggregates, grading of----322
Batch mixing----145
Bituminous binder----143
Continuous mixing----147
Drying----149
Measurement and payment---- 153-154
Proportioning----150
Prime coat----143
Spreading and compacting equipment----147
Spreading and compacting mixture----150
Subgrade----150
Plate culverts structural (field assembled)----244
Plates-
Bronze----202
Web for steel structures----199
Wrought iron----351
Pneumatic-tired rollers----105, 148
Pole lines, protection of----39
Portland cement----349
Portland cement concrete (see concrete)----156
Portland cement concrete structures (see structures)----169
Post, fence----372
Posts, guard railing----272
Posts, guide and markers----275
Precast concrete piles----217
Preference, order of plans and specifications----18
Preparation of ground for embankments----85
Prequalifications of bidders----7
Preservation of property----36
Preservative for timber----231, 371
Prime coat----121
Production, roadside----42
Progress estimate----53
Progress of work, prosecution and----42
Progress schedule----45
Property, preservation of----36
Property rights in materials----24
Proposal-
Alterations of----9
Consideration of----11
Forms, contents of----7
Forms, delivery of----9
Forms, signing of----8
Guaranty----4,9
Guaranty, forfeiture of----9
Guaranty, return of----11
Interpretation of Quantities----8
Irregularities in----8

Proposal-Continued-
Public openings of----9
Rejection of----9
Requirements and conditions of----7
Time of opening of----9
Withdrawal or revision of----9
Prosecution and Progress----42
Protection of pole lines----39
Protection of property----36
Protection of trees----63
Protests of contractor----17
Provisions, special----4, 18
Public traffic, safety----56
Public opening of bids----9
Pumping----93, 176
Punched work----193

Q

Qualification of bids----10
Quality of materials and source of supply----24
Quantities, altered----13
Quantities, measurement of (see sections for various items)----48
Quantities, Interpretation of----8

R

Railing for concrete structures----184
Railing for timber structures----210
Rail, guard----272, 376
Railing, steel bridge----205
Railroads, relations with----34
Raised traffic bars----281
Ready-mixed concrete----163
Reamed holes in steel structures----193
Redwood lumber and timber----366
Refund of motor fuel tax----10
Registration of contractors----7
Reinforced concrete pipe culverts----237, 359
Reinforcing Steel----187
Reinforcing steel-
Bending diagrams----187
Fabrication----187
Materials----187
Measurement----188
Mesh----188
Payment----189
Placing and fastening----188
Protection----187
Splicing----188
Substitutions----188
Rejections of proposals----9
Relative compaction----28, 85, 89, 95, 108
Relaying culvert pipe----246

Relief from maintenance----38
Removal of-
Brush----63
Buildings----72
Concrete pavement and structures----69
Defective and unauthorized work----21
Electrical facilities----39
Existing improvements----66, 69
Falsework----178
Obstructions----75
Old steel structures----66
Oversize rocks and lumps----74
Pipe culverts----66
Pipe headwalls----66
Slides----75
Structures----69
Trees----64
Unauthorized work----21
Utility facilities----70
Requirements and conditions, proposal----7
Reshaping roadway----99
Responsibility-
Contractor's responsibility for local materials----24
Contractor's, for work----39
Contractors, for damage----37
Injury to persons----37
Legal relations and----32
Materials----25
Public officials----40
Railroads----34
Sanitary provisions----33
Restriction, Load and speed----22
Retention of moneys due----53
Retention of wood preservatives----231, 272, 275
Return of proposal guaranties----11
Right of way markers----279
Riprap----254
Riprap-
Grouted----254
Heavy----254
Light----254
Measurement of----255
Payment of----256
Sacked Portland cement----255
Riveted and soldered CMP----235
Riveted steel structures----202
Rivets and bolts----194
Rivets, steel----350, 194
Road-mixed surfacing----131
Road-mixed surfacing-
Aggregate----133
Bituminous binder----125, 134
In-place material----132

Road-mixed surfacing-Continued-
Measurement and payment----137
Mineral aggregate----131
Mixing----134
Prime coat----133
Roadbed preparation----132
Seal coat----133
Spreading and compacting----136
Spreading untreated material----133
Roadside cleanup----100
Roadside production----42
Roadway-
Embankment----85
Excavation----73
Reshaping----99
Rock riprap----254
Rocks, removal of oversize----74
Rollers, pneumatic-tired----105
Rolling----103
Rolling embankments----89
Rounding of slopes----83
Royalties----32
Rubber gasket joints----240
Rubble masonry----257-259
Rules for overhead electric line construction----283

S

Sacked concrete riprap----254
Safety, public convenience and----33
Salvaging existing improvements----70
Salvaging drainage facilities----70
Samples and tests----27
Sandblasting and cleaning----222
Sand for portland cement concrete----331
Sanitary provisions----33
Scales, requirements for (see sections for various items)----49
Schedule, progress----45
Scope of payment----50
Scope of work----13
Screenings----324
Seal coat----123
Sections open to traffic----38, 58
Selected material, surface course----110, 319
Settlement of disputes----17
Sewer pipe----365
Shop drawings----190
Shrink-mixed concrete----163
Sidewalks (see curbs, gutters and sidewalks)----262
Signals and lighting----283
Signals and lighting-
Ballasts, transformers and----314

Signals and lighting-Continued-
Bonding and grounding----294
Cable, conductors and----291
Code, regulations and----283
Color phases----298
Conductors and cables----291
Conduit----288
Controller housing----303
Controller vents----303
Controller, pre-timed----304
Controllers, traffic-actuated----299
Controllers, traffic signal----298
Detectors----309
Detectors, calling----310
Detectors, directional----309
Detector foundations----310
Directional louvers----308
Electrical code and regulations----283
Equipment list and drawings----283
Expansion fittings----291
Field test----296
Flashers----312
Flashing beacons----312
Flashing operations----298
Foundations----285
Grounding, bonding and----294
Guaranty----315
Guard posts----288
Inspections----295
Installing signal heads----307
Interval timer for pedestrian actuation----302
Luminaires----311
Mounting brackets----308
Operating voltage----298
Optical units, signal----307
Painting----296
Payment----316
Pedestrian push buttons----310
Pedestrian signal heads----311
Pedestrian signals "wait-walk"----311
Photoelectrical controls----313
Pre-timed controller, auxiliary equipment----304
Pull boxes----290
Radio interference suppressors----298
Regulations and code----283
Reinstalling salvaged equipment----314
Safety precautions----295
Salvaging electrical equipment----314
Service----294
Sign lighting fixtures----312
Sign switches----295
Signal heads----307
Signal head back plates----308

Signals and lighting-Continued-
Signal head housing----307
Signal head mounting----309
Signal head optical units----307
Standards, light----286-287
Standards, sign----286-287
Standards, traffic signal----286-287
Suppressors, radio interference----298
Switches, sign----295
Test, field----296
Timers, interval, for pedestrian actuation----302
Traffic-actuated controllers----299
Transformer----314
Wiring----293
Wiring diagrams----292
Signs, illuminated (see signals and lighting)----283
Signs, warning----34, 60
Siphons, corrugated metal----234
Siphons, joints for----235, 240
Siphons, reinforced concrete pipe----237
Site of work, examination of----8
Sites, material----25
Slides----75
Slope paving----266
Slopes, rounded and transition----83
Slump test----162
Source of material, local----24
Source of supply and quality of materials----24
Special provisions----4, 18
Special provisions, specifications and plans, coordination of and order of preference----18
Specifications, alterations of----13
Specifications, examination of----8
Specifications, interpretation of plans and----18
Specifications and plans, order of preference----18
Specifications, special provisions and plans, coordination of----18
Speed, Regulations, load and----22
Stakes, construction, preservation of----20
Statement, financial----7
Statement, prequalification----7
Steel (see steel structures)-
Reinforcement----352
Castings----351
Piles----218
Steel, paint for----224
Steel reinforcing----187
Steel structures----190
Steel Structures-
Abutting joints of members----198
Angles for connection----199
Annealing parts----200
Assembly, shop----193
Bearings and anchorage----202

Steel structures, Continued-
Bolts----194, 197
Bronze castings----351
Castings----351
Cleaning and painting----200, 224
Computed weights----204
Connection angles----199
Cutting----198
Drawings----190
Drifting of holes----194
Drilled holes----193
Edge planing and facing of bearing surfaces----198
End connection angles----199
Eye-bars----200
Facing of bearing surfaces----198
Falsework----201
Finish----201
Handling and storing materials----192, 201
Inspection of----191
Lacing bars----199
Match-marking parts ----66, 193, 201
Materials and testing----190, 350, 351
Measurement and payment----203, 205
Methods and equipment----201
Packing----201
Painting----200, 224
Payment, measurement and----203, 205
Pin connections----200
Punched work----193
Reamed work----193
Removal of old structures----66
Rivets----194, 350
Riveting----202
Rollers, pins and----200
Screw threads----200
Shipping materials----201
Siffeners, fit of----199
Straightening members----192
Web plates----199
Weighing materials----203
Weights of materials----203
Welding----199
Workmanship----190
Wrought iron plates----351
Stone riprap and masonry----330
Storage of materials----30
Structure backfill----95
Structure backfill-
Backfill measurement----96
Backfill payment----97
Structure excavation----91
Structure Excavation-
Excavation measurement----93
Excavation payment----94
Structural steel (see steel structures)----190

Structural timber (see timber structures)----206
Structures, concrete----169
Structures, concrete-
Aprons and slope paving----266
Backfill for----95
Cofferdams----92
Concrete deposited under water----176
Construction methods----169
Curing concrete----179
Cyclopean concrete----178
Depths of footings----91,169
Drainage and weep holes----184
Excavation for----91
Falsework----172
Finishing----182
Forms----169
Joints----177,180
Measurement and payment for----184
Mixing concrete----172
Patching----181
Placing concrete----173
Pumping----176
Removal of----66
Removal of falsework, forms and housing----178
Rubber waterstops----180
Slope pavement and aprons----266
Surface finish----182
Waterproofing----184
Structures, Excavation for----91
Structures excavation of-
Classification----91
Foundation seal----93
General Requirements----91
Inspection----93
Measurement of----93
Payment of----94
Pumping----93
Structures, removal of----66
Structures, steel (see steel structures)----190
Structures, timber (see timber structures)----206
Strutting-
Corrugated metal pipe----234
Structural plate culverts----244
Sub-contracting----42
Subgrade Preparation-
Concrete slope paving and aprons----266
Curbs, gutters and sidewalks----262
Plant-mixed surfacing----150
Selected borrow----79
Subletting and assignment----42
Substitute material----25
Superintendence of work----19,44

Supply of materials, source and quality----------24
Surfacing-
Armor coat----------128
Plant-mixed----------141
Retread surface----------139
Road-mixed----------131
Surface treatment----------125
Surplus excavation----------73
Suspension of work----------44

T

Tax, motor fuel, refund of----------10
Temperatures (application of Bitminous Binders)----------112
Temporary suspension of work----------44
Tension cable for chain link fence----------269
Termination of contract----------47
Terms, definitions and----------1-6
Test of materials (also see sections for various items)----------27
Test piles----------218
Test, cost of----------27
Testing local materials----------27
Tile drains----------248
Timber piling----------212,368
Timber structures----------206
Timber structures-
Construction----------206
Grading rules----------206,366
Hardware----------353
Inspection----------367
Lumber----------366
Material----------206
Measurement and payment----------211
Metal connectors----------353
Painting----------210
Payment----------211
Preservative treatment----------231,371
Railing----------210
Structural metal----------208
Structural timber----------366
Time of award of contract----------11
Time of completion of contract----------43
Time, extension----------45
Time of opening proposals----------9
Traffic-
Bars, raised----------281
Convenience and safety of public traffic----------56
Maintaining----------58
Sections open to traffic----------38,59
Signals (see signals and lighting)----------283
Transit-mix concrete----------163
Treatment of lumber, timber and piles,-----207,216,231,273,275,279
Treatment of lumber, timber and piles-
Brush treatment----------232

Treatment of lumber, timber and piles, Continued-
Pile heads----217
Preservatives----371
Retention----231
Trees, protection of----63
Trees, removal of trees and roots----63
Tremie concrete----177
Twenty-five percent clause----13

U

Unauthorized work, removal of----21
Unbalanced bids----9
Underdrains----248,356
Unpaid claims----10
Unsuitable materials, roadway excavation----75
Unsuitable weather conditions----44,56,113,122,123,126,134,150
Use of materials found in the work----15
Utility facilities-
Cooperation with----20
Delays to contractor's operations----20
Existing----20
Liability of Contractor for----36,39
Relations with railroad----34
Removing and relocating----70
Underground facilities----39

V

Vibrators, concrete----173
Volumes of asphaltic materials, conversion tables for----116-120
Volumetric measurement----49-50

W

Wages and conditions of employment----55
Walls-
Drains in concrete----184
Rubble masonry----257
Wall thickness of concrete pipe----359-364
Warning signs----34,60
Water----318
Water channels----74
Water for concrete----318
Watering----101
Waterproofing and dampproofing----185
Waterstops, rubber----180
Weather conditions, unsuitable----44,56,113,122,123,126,134, 150
Web plates----199
Weighing materials (also see sections for various items)----49
Weights of asphaltic emulsions----116
Weights of liquid asphalts----116
Weights of materials----48
Weights of asphalt cements----116

Weights of reinforcing steel----------189
Weights of structural steel----------204
Welding----------199
Widening cuts----------76
Wire-
Barbed----------269
Chain link mesh----------269
Woven wire (Farm) mesh----------269
Withdrawal of proposals----------9
Wood preservative treatment----------231,371
Work-
Access to----------21
Assignment of contract----------42
Changed conditions of----------13
Completion time of----------46
Contractor's responsibility for----------39
Control of----------17
Defective----------21,46
Examination of site of----------8
Extra----------15,51
Failure to complete on time----------46
Final cleanup----------16
Force account----------15,51
Increased or decreased quantities----------13
Inspection of----------21,22
Limitation of operations----------43
Measurement and payment for----------48
Notice to proceed----------43
Progress and prosecution of----------42
Removal of defective and unauthorized----------21
Responsibility for----------61
Rights in and use of materials found in the----------15
Scope of----------13
Special----------13
Subcontracting of----------42
Temporary suspension of----------44
Working day, definition of----------5
Working drawings----------17
Workmanship of steel structures----------190
Workmen, character of----------44
Wrought iron plates----------351

(20/25) 17

(15/20)

(30)

(2.5)